BEEF CATTLE MANAGEMENT SYSTEMS FOR THE SOUTHEAST: AN APPLICATION OF COMPUTER MODELING

by

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Two mathematical models for the evaluation of beef production systems were developed and computerized using DYNAMO programming. The first model, a cow efficiency estimator, computed the TDN requirements for a cow and her calf using variables such as animal weight and gains, seasonal changes in cow weight, cow milk production, physical activity of the animals, and the quality of feed being consumed.

The second model, a herd efficiency estimator, used data from the first model plus data on cattle prices, fixed costs, pregnancy and calf survival rate, death losses, heifer replacement and culling policies, herd size, and TDN produced per acre from each TDN source. This model calculated biological efficiency factors such as TDN per unit of beef sold, beef produced per land unit and economic efficiency factors including cost and net returns per unit of beef sold and net returns per land unit.

The models were tested using data collected over a nine year period at the University of Florida Beef Research Unit. They were

then used to evaluate five feeding and pasture systems suitable to the southeastern United States. Animal production traits, market structures, and herd culling procedures were also studied.

Cow size had no effect on measures of biological efficiency. In general, cow size had little or no effect on profitability except that large cows were at a disadvantage when a relatively expensive high-energy corn silage ration was fed to brood cows.

Increasing milk yield improved biological efficiency, decreased costs, and improved returns at weaning. However, if the calf was maintained in the herd and finished to slaughter weight, there was no advantage to high milk yields in the cow herd.

Fertility was the only animal production characteristic examined in the study which consistently showed a substantial effect on profitability. Increasing fertility always increased profitability.

The pasture and feeding system used had a substantial effect on biological efficiency and profitability. A confinement system in which brood cows were fed corn silage in a drylot had the lowest TDN per unit of beef produced but was uniformly unprofitable. A semi-confinement system in which brood cows were heavily stocked at 1.67 animal units per acre and supplemented with corn silage rated second in measures of biological efficiency. With high cattle prices it also gave the greatest returns per land unit. In the other three systems examined, cow-calf production occurred on clover-grass pastures. Calves went directly into the feedlot or were grazed on annual forages or topseeded perennial pastures before a short feedlot finishing phase. A system in which calves were grown out on topseeded perennial grass pastures had the lowest cost per unit of beef produced and the highest

return per unit of beef sold. It also surpassed the semi-confinement system in net returns per land unit when cattle prices were low.

The method by which non-pregnant cows are removed from the herd was demonstrated to have a substantial effect on profitability. The most profitable procedure was to detect and immediately cull non-pregnant cows as soon as they weaned their last calf. Profits were substantially reduced by delaying culling until six months after weaning or by culling a fixed percentage of the cow herd at the end of the production year regardless of pregnancy status.

The models developed in this study are flexible, easy to use, and inexpensive to run. When adequate input data for a given area and time are known, the models can be useful tools in building recommendations for an optimum beef production system.

CHAPTER I
INTRODUCTION

The chief concern of most beef producers is to maximize some economic objective, usually net returns. To accomplish this objective, the producer must first decide what kind of production system will yield the greatest profits. The second step is to decide how to manage both the animals and their environment to achieve this optimum production system. Animal scientists can usually supply producers with extensive information regarding animal selection, the nature of the selection response, animal nutrition, reproductive physiology, and meat quality. Up to the present, however, animal scientists have not been able to give producers much help in choosing production goals. The inadequacy of research efforts in this regard has been pointed out by Gregory (1972) and Harris (1970).

To evaluate alternative production goals the producer must evaluate entire production systems. If animal scientists are to assist livestock producers in selecting production goals, they must adopt research techniques for analyzing entire production systems. One of the major techniques used in many fields but, until very recently not applied in animal science, is computer modeling.

Scientists in many disciplines conduct experiments with models rather than performing the experiments under field conditions. Engineers, for example, have used models of structures such as buildings, bridges, or airplanes for experimental testing before building the

actual structure. If a system can be accurately described and expressed in explicit quantitative terms, then it is possible to construct a mathematical model of that system and to use a digital computer to perform calculations that represent the behavior of the system.

Mathematical models of beef systems can be constructed for several levels of production. These levels are as follows:

I. Region/country/world

II. Herd

III. Individual animal

IV. Sub-systems of individual animals (e.g. digestive system, reproductive system)

Techniques are available which would allow modeling at all levels. The limiting factor in modeling beef systems is not modeling technique but lack of basic input information and data to build and execute valid models. The most extensive and reliable input information and data exist at levels II and III. The efforts of this study involved levels II and III since information about these levels could be most readily applied by beef producers.

Most beef production models reported thus far at the individual cow and herd level have used a linear programming (LP) technique. The study reported here differed in that it employed the DYNAMO computer language (Pugh, 1970). While LP is a convenient technique commonly used by agricultural scientists, its usefulness is restricted by a rigorous set of assumptions outlined by Heady and Candler (1958). LP assumes "linearity." Thus non-linear relationships, such as nutrient requirements for maintenance and growth, must be approximated in an LP model by the use of pre-calculated coefficients or by subdivision

into several activities. This subsdivision process may lead to problems with the LP assumption of "finiteness." Only a limited number of activities or equations may be considered. Otherwise, the model becomes too costly to run and too cumbersome to interpret. This assumption of finiteness also requires the specification of limits on the supply of each resource. Other problems may arise with the LP assumption of "single-value expectations" especially when a value changes with time as, for example, with cow milk yield as lactation progresses or pasture TDN values as the season changes.

None of the restrictions mentioned above for LP models are serious problems when using DYNAMO. Nevertheless, DYNAMO is not an optimizing technique as is LP. Optimizing can be done with DYNAMO by using a series of runs, though this reiteration approach may become burdensome if large numbers of interacting variables are involved. Generally, however, livestock production models do not require optimization since animal-environment interactions preclude the existence of a universally optimum production system. The objective of livestock production modeling should be to gain an understanding of the behavior of different production systems and their associated animal-environment interactions. A more versatile modeling technique such as DYNAMO makes this objective easier to achieve.

It was the goal of this study to develop a mathematical model for analyzing beef production systems and, with the aid of a computer, to use the model to represent beef systems which are currently in use or which might be feasible in the future for parts of the southeastern United States. More specifically, the objectives of the research were to:

1) Develop a model which, with minor adaptations, could be used to evaluate any beef production system where standard input data are available.

2) Estimate the effects of production variables such as cow size, fertility, milk yield, and calf gain on production efficiency and profitability.

3) Estimate the effects of certain environmental factors such as feeding and pasture systems, herd management procedures, and markets on production efficiency and profitability.

4) Examine alternative beef production systems for the southeastern United States, especially Florida and the lower Coastal Plains.

5) Evaluate possible interactions between animal production characteristics and the environment in which the production occurs.

CHAPTER II
REVIEW OF LITERATURE

Building a realistic model of a beef production system entails the interrelating of many variables and requires data and information from all stages of the beef production cycle. This information, of course, must come from many separate sources. Thus, a reservoir of compatible data and information must be assembled for the successful construction and execution of a beef system model. This chapter is a review of some of the literature which influenced the development of the models and the evolution of the study.

Beef Production: The Cow

Cow Size

In a review of mature cow weights, Warwick (1971) reported average weights of about 800 to 1300 pounds for British breed cows, with most weights in the 1000 to 1200 pound range. Cow weight, however, may not always be a good measure of cow size. O'Mary, Brown, and Ensminger (1959) used 15 body measurements to reflect cow size. Klosterman, Sanford, and Parker (1968) found condition and weight-height ratio to be highly correlated, emphasizing the importance of cow condition in size determination. The effects of season, lactation status, and pregnancy status were illustrated in a study by Vaccaro and Dillard (1966). They found that cows lost weight at parturition and continued to lose weight for 60 days after calving; then began to gain. Fitzhugh, Cartwright, and Temple (1967), found that age accounted for a significant portion of cow weight.

Cow weight seems to be the most obvious and readily available indicator of cow size. However, if weight is to be used as a measure of cow size, then factors such as cow condition, pregnancy status, lactation status, age, and season need to be specified.

Milk Yield

The milk yield of a cow may be influenced by her breed, age, size, plane of nutrition, and stage of lactation. Joandet and Cartwright (1969) reported average daily milk yields of 7.4 to 12.0 lbs/day for British-Brahman cross cows. Dawson, Cook, and Knapp (1960) reviewed data and suggested a range of 6 to 13 lbs/day for Angus and Hereford cows. Melton, Riggs, Nelson, and Cartwright (1967) observed values of 7 to 10 lbs/day for the Angus, Hereford, and Charolais cattle used in their study. These same authors also reported that milk yield increased with cow age and that cows nursing bull calves gave more milk than cows nursing heifer calves.

The relationship of milk yield to cow size is well recognized in dairy cattle (Preston and Willis, 1970). Harville and Henderson (1964), for example, reported a correlation between body size and milk yield of approximately 0.4.

The effects of stage of lactation on milk yield has been demonstrated in several studies. Dickey (1971); Rutledge, Robison, Ahschwede, and Legates (1971), and Melton, Riggs, Nelson, and Cartwright (1967) all reported a decline in milk yield as lactation progressed.

Fertility

The works of Cunha, Warnick, and Koger (1967) and Preston and Willis (1970) provide excellent reviews of the many factors affecting fertility in the beef cow. These factors include breed, age, nutri-

tion, environment, herd management, milking level, and lactation status

Of special interest in this study are the effects of milk yield and cow size on fertility levels. Neither of these factors have been studied thoroughly. Willham (1972) reviewed works suggesting that reproductive performance is lowered by increased milk production.

Butts (1972) cited evidence that pregnancy rate is correlated with cow size. Cartwright communicated to him data indicating a negative correlation (r= -.235) between number of calves weaned per year and mature size. Sanders in Tennessee also reported to Butts a negative correlation of -.45 between shape of weight-age curve of cows and reproduction, although this correlation tended to disappear where adjustments were made for variation in body composition. These studies suggest that fertility in the modern beef cow may decrease as cow size increases.

Beef Production: The Calf

Birth Weight

The birth weight of calves is affected by numerous factors, including sex of calf, age of dam, breed, nutrition of dam and weight of dam. Work by Lampo and Willen (1966) illustrated the effect of sex of calf and age of dam. Franke, England, and Henry (1965), examining six sire breeds and a variety of dams, found breed of dam to be the most important factor in determining calf birth weight, although dam breed accounted for only 7.4% of the total variance . The influence of diet and level of nutrition of the dam has been demonstrated in studies by Clanton, Zimmerman, and Albin (1964) and Smithson, Ewing and Renbarger (1966).

Probably the most important factor affecting calf birth weight is

the weight of the dam. Lampo and Willen (1965) obtained correlation coefficients of 0.43 to 0.55 between dam pre-calving weight and calf birth weight. Vaccaro and Dillard (1966) also noted that the heaviest cows 90 days before calving had the heaviest calves.

Weaning Weight

In a classic study in 1945, Koger and Knox proposed a method for estimating weaning weight of calves at a constant age. Weaning weight is an easy, convenient trait to measure and since that 1945 report has been studied intensively. Weaning weight can vary with calf age, sex, breed, birth weight, and by age, size, and milk yield of dam.

Preston and Willis (1970) reviewed studies of the effects of breed, sex, and dam age on weaning rates. For calves weaned at 200 to 215 days of age, average weaning weights were reported to vary from 282 to 509 pounds. In a recent comprehensive study of beef production traits for different breeds, researchers at the U. S. Meat Animal Research Center (1975) found 200-day weaning weights to vary from 395 pounds for a straightbred Hereford calves to 558 pounds for Angus-Brown Swiss F_1 calves out of Swiss dams. These data were for dams 4 years or older. Environmental factors also add to the great variability found among weaning weights in different studies.

Vaccaro and Dillard (1966) studied the relationship between dam weight and calf weight changes. They found that the heaviest cows 90 days prepartum tended to produce the heaviest calves at weaning. Older cows also produced heavier calves. They noted that birth weight of calf was the most valuable predictive measure of gain to weaning at 180 days.

Butts (1972) reviewed the relationship between cow weight and weaning weight of progeny. He summarized reports which showed increases

in weaning weight of 0 to 15 pounds for each 100 pounds increase in cow weight. As pointed out by this author, however, cow weight may be an inadequate measure of cow size. O'Mary, Brown, and Ensminger (1959) reported a correlation coefficient of 0.51 between cow weight and calf weaning weight. They also found a multiple correlation coefficient of 0.91 between three body measurements of a cow and the weaning weight of her calf. Thus when cow size can be adequately determined it appears to be highly correlated with calf weaning weight.

The effect of milk yield on weaning weight has also been studied extensively. Milk yield and weaning weight are highly correlated. In 13 studies reviewed by Preston and Willis (1970) the correlation coefficient between milk yield and weaning weight varied from 0.14 to 0.91. Most reports ranged from 0.4 to 0.6.

Post-Weaning Growth

Preston and Willis (1970) considered six major factors which influenced post-weaning growth. These factors included breed, sex, exogenous hormones, nutrition, environment, and management. In this study, nutritional programs are the factors of chief concern.

After weaning, most calves will either go directly into a feedlot where they are fed a high-energy ration or they may graze a high quality forage. This forage program may include some grain supplementation or may be concluded with a short feedlot phase to improve carcass quality.

Placing calves directly into a feedlot offers the advantage of rapid growth. However, the slower gains attained by grazing high quality forages may be the least expensive gains.

In an extensive comparison of breed differences, the U. S. Meat Animal Research Center (1975) in Nebraska fed weaned calves for periods ranging from 220 to 282 days. Gains varied from 2.02 lbs/day for Red

Poll-Angus crossbreeds to 2.66 lbs/day for Maine Anjou-Hereford crosses. In Georgia, Chapman, Utley, and McCormick (1971) attained daily gains of 2.73 to 2.82 lbs for Hereford and Hereford crossbred weanling steers fed for 204 days. Similar gains have been reported by Florida researchers. Baker, Crockett, Carpenter, West, and Palmer (1974) fed crossbred steers for 178 days on a high moisture corn ration. They obtained daily gains of 2.84 lbs. Bertrand, Lutrick, and Dunavin (1974) achieved daily gains of 2.48 to 2.83 lbs using a dry corn ration and a feeding period of 128 to 146 days. These investigators also reported significantly lower gains where grain sorghum was substituted for corn in their rations.

The gains reported for forage systems have been highly variable, even for different investigations of the same type forage. These variations are not surprising since environmental factors such as season and grazing management practices are known to have significant influences on the results of grazing trials.

Daily gains on winter grazing in Florida, Georgia, and Alabama, have varied from 1.58 to 2.3 lbs (Baker, 1975; Harris, Anthony, Brown, Boseck, Yates, Webster, and Barrett, 1971; Anthony, Hoveland, Mayton, and Burgess, 1971; Utley, Marchant, and McCormick, 1976). For the summer annuals, millet and sorghum-sudan grass, investigators in the same three states have reported gains of 1.06 to 2.13 lbs/day (Baker, 1975; Hoveland, Harris, Boseck, and Webster, 1971).

On perennial sods, Utley, Marchant, and McCormick (1976) obtained average daily gains of 1.26 lbs on Pensacola babia, 1.41 lbs on Coastal bermuda and 1.58 lbs on Coastcross-1 bermuda. Oliver (1976) grazed steers on Coastal bermuda from May through September and reported daily gains of 1.16 lbs for European cross steers and 1.58 lbs for Brahman cross steers.

Both groups gained about the same in the month of May but the Brahman cross calves showed a progressive advantage as the season advanced. The author concluded that the Brahman calves used lower quality forage more efficiently.

Compensatory Growth

Calves which have been maintained on a low plane of nutrition will gain faster and more efficiently than calves of similar weight which have been well fed. This phenomenon is known as compensatory growth and has been documented by Winchester and his associates (Winchester and Howe, 1955; Winchester and Ellis, 1956; Winchester, Hiner, and Scarborough, 1957). These authors studied the effects of both energy and protein levels in identical twin calves 3 to 12 months old. The calves were fed rations varying from maintenance to liberal levels, then all were switched to the liberal ration. There were no significant differences in the amounts of energy consumed over the entire trial period or in carcass quality or dressing percent. Calves fed the restricted diet required a longer period of time to reach slaughter weights.

Meyer, Hull, Weitkamp, and Bonilla (1965) assigned calves which had been on restricted diets to four energy intake levels including three different grazing intensities. Compensatory growth always occurred during this second phase of their experiment, even where the second phase energy intake level was low.

These studies on compensatory growth illustrate the importance of carefully defining the overall life history of a calf when modeling its entire life cycle. They also demonstrate the need for caution in interpreting gain data from experiments where previous history of the cattle is not indicated.

Forage and Feeding Systems

In the southeastern United States, beef production has traditionally occurred in three phases. These phases include the cow-calf phase, the stocker phase, and the feedlot phase.

The cow-calf phase nearly always occurs on perennial grass pasture, frequently with some supplemental feed such as hay or silage during the winter. One of the most extensive cow-calf pasture studies was conducted in Florida (Koger, Blue, Killinger, Greene, Myers, Warnick, and Crockett, 1970). Calves were produced on all-grass and clover-grass pastures planted on "flatwoods" soil -- a somewhat poorly drained Leon fine sand. The most productive program yielded 385 lbs of calf per acre per year on a clover-grass mixture stocked at 0.7 cows per acre. This pasture received only 30 lbs of P_2O_5 and 60 lbs of K_2O per year. Additional P_2O_5 and K_2O did not increase the amount of beef produced per acre. An all grass program which received 120 lbs of N, 45 lbs of P_2O_5 and 90 lbs of K_2O carried 0.71 cows per acre and produced only 332 lbs of calf per acre. These production rates and carrying capacities were for pasture only and did not include the use of an additional 0.13 acre per cow for growing corn silage used as a winter supplement. With the silage land included, beef produced per acre would have been 351 lbs for the clover-grass pasture and 304 lbs for the all-grass pastures.

Neville and McCormick (1976) in Georgia used heavily stocked Coastal bermuda pastures for a cow-calf program. Including hay land, they stocked cattle at 1.01 and 0.75 cows per acre during a two year study. The heavily stocked pastures received 288 lbs of N, 72 lbs of P_2O_5 and 144 lbs of K_2O per acre, while the more lightly stocked pasture was fertilized at about one-half this rate. These two treat-

ments produced 355 and 292 lbs of calf per acre, respectively.

One highly productive cow-calf program was a 16-year Louisiana study reported by Doane (1976). Twenty-four cows were grazed on 16 acres of Coastal bermuda which was topseeded each fall with clover and ryegrass and fertilized with 293 lbs of N annually. All of the hay to meet winter feed requirements was also produced on the 16 acres. Each acre produced 641 lbs of beef plus one-half ton of surplus hay per year.

Franke (1970) surveyed confinement cow-calf systems. Problems with confinement systems included high calf death loss and high costs per cow-calf unit. He did not report on the amount of beef produced per acre though he did quote a producer who claimed a 50% increase in herd size was made possible by drylotting his cows during the fall and spring.

After weaning, most cattle in the southeastern United States enter a stocker phase during which they are grazed on either annual or permanent pastures. Annual pastures are the most popular since they can be grown during both winter and summer and provide higher quality feed than the warm season perennials.

Clover-rye-ryegrass mixtures have been used successfully for growing calves during the winter and early spring months. In a 10-year study at Alabama (Harris, Anthony, Brown, Boseck, Yates, Webster, and Barrett, 1971) such a mixture produced 186 days of grazing beginning in early November. The stocking rate was 1.3 calves per acre with an average daily gain of 1.48 lbs. Beef production per acre was 390 lbs. Anthony, Hoveland, Mayton, and Burgess (1971) achieved a similar production rate of 394 lbs per acre with an arrowleaf clover-rye-ryegrass mixture grazed for 193 days. Their steers gained 2.05 lbs/day when

stocked at one animal per acre. Baker (1975) stocked rye-ryegrass pastures more heavily to attain 420 lbs of gain per acre during a 163 day grazing season with an average daily gain of 1.58 lbs.

Utley, Marchant, and McCormick (1976) reported 453 lbs of gain per acre and 2.3 lbs of gain per animal per day from either oats or rye-grass planted on a prepared seedbed. When these annuals were top-seeded on permanent pastures, however, they were slower to develop and provided only 222 lbs of gain per acre before the summer perennial grasses dominated the sward. The permanent pastures in this study produced an additional 441 to 531 lbs of gain during the summer growing season. The summer annuals in this same study produced 334 to 467 lbs of gain per acre (about 2 lbs per animal per day). Other studies have reported much lower gain rates on summer annuals. Bertrand and Dunavin (1970) obtains 344 lbs of weight gain per acre with a gain rate of 1.18 lbs per animal per day during an 86-day grazing season. Hoveland, Harris, Boseck, and Webster (1971) produced 210 lbs of gain per acre during a 77-day grazing season on summer annuals. Their average daily gain was 1.1 lbs.

Calves may go from the stocker phase directly to slaughter or into a feedlot phase. They might also bypass the stocker phase and go directly into the feedlot where they will be fed a high energy grain ration. Baker, Crockett, Carpenter, West, and Palmer (1974) and Bertrand, Lutrick and Dunavin (1974) have demonstrated the practicality of finishing beef calves on predominantly grain rations in the south-eastern United States.

Beef Production Efficiency

During recent years there has been a dramatic increase of interest

in factors influencing beef production efficiency. The literature contains numerous theoretical treatments and reviews of this subject. Klosterman (1972) concluded that, generally, medium size cattle will be the most efficient but that no one size will be most efficient under all conditions. Butts (1972) suggested that cow size is related to production efficiency through its relationship with other factors in the production cycle, and that these relationships need more study before it is possible to design production systems of maximum efficiency. Willham (1972) concluded that, while some breeds need improved maternal ability, the maximization of milk production as a means of improving efficiency does not seem to be a realistic goal, especially in view of the detrimental effect of high milk yields on reproductive performance. In a discussion of the effects of breeding programs on production efficiency, Cartwright (1970) predicted that there will be a growing emphasis on increasing output per unit of input on a herd rather than on an individual basis. Cartwright also suggested that greater emphasis will be placed on specialized herds or breeds, and on utilizing hybrid vigor. Hendrick (1972) reviewed the effects of body type on production efficiency and concluded that size or form of the animal is not as important as meat quality and the proportions of lean meat produced.

The undertone of all these reviews was echoed by Harris (1970) in a theoretical discussion of breeding for economic efficiency in livestock production. Harris noted that most of the research in animal breeding to date has been concerned with methods of genetic evaluation and the nature of the selection response. Efforts to define realistic selection goals have not been adequate.

Attempts have been made to examine beef production efficiency experimentally. Kress, Houser, and Chapman (1969) indicated that re-

productive performance was more closely related to efficiency than any other variable and that large cows were the most profitable. Joandet and Cartwright (1969) developed a method for determining the point at which cumulative TDN required to produce a unit of live weight is minimal. They called this point the optimum slaughter weight. Melton, Cartwright, and Kruse (1967) reported that small cows were the most efficient in terms of units of input per pound of calf produced.

Investigators in Texas have studied beef production efficiency using computer models for beef production and data from Texas experiment station herds supplemented with parameter estimates from other research. In an early study Long and Fitzhugh (1969) concluded that small cows were more profitable than large cows. However, in a subsequent study (Long, 1972) indicated that large cows were favored in a straightbreeding system when fed a high energy, least-cost ration. When fed on pasture and harvested forage, medium size cows were most efficient. In still another study (Long, Cartwright, and Fitzhugh, 1975) this group reported that large cows were more profitable on a drylot regime and small cows were more profitable on a pasture regime. These Texas workers, however, have consistently pointed out the interactions between factors such as cow size, milk yield, progeny performance, and production environment and have cautioned against the concept of a universally optimum animal type.

It is obvious that the study of beef production efficiency is in its infancy. Production data on all phases of beef production cycle, the interactions between animal production factors and environmental factors, techniques for examining beef production efficiency, and definitions of production efficiency are all factors which will need

improvement as this field of study progresses.

Breeding Systems

A popular approach in studies of beef production efficiency has been to compare the efficiencies of different breeding systems. In a theoretical treatment, Moav (1966) proposed specialized sire and dam lines to improve "profit heterosis." Cartwright (1970) has been a proponent of specialized sire and dam lines to improve beef production efficiency. He and his Texas associates (Long, Cartwright, and Fitzhugh, 1975; Fitzhugh, Long, and Cartwright, 1975; Cartwright, Fitzhugh, and Long, 1975) published a series of papers in which they assessed the effects of several breeding systems on net income and return on investment. They concluded that breeding plans in which large sires were mated to either F_1 or crossbred cows were more favorable than straightbreds or two breed crosses.

Systems of crossbreeding and crossbreeding experiments have been reviewed by Koger, Cunha, and Warnick (1973) and by Cundiff (1970). The review by Cundiff indicated that heterosis was greatest for traits of low to moderate heritability (e.g., early growth, fertility, and survival) and least for traits of high heritability (e.g., post weaning growth and carcass merit). This conclusion implies that crossbreeding may be used to improve traits such as fertility but will not have a substantial effect on highly heritable traits like post weaning growth and carcass merit. Another study by Cundiff, Gregory, and Long (1975) suggested that breeders have applied much selection pressure for growth traits but very little selection for carcass traits. These investigators estimated the correlation between several breeding values of sires produced within the same herd. The correlation was high (0.51) for

growth traits and low (0.16) for carcass traits. They concluded that the high breeding value correlation for growth traits indicates substantial genetic diversity probably arising from differential selection pressure and response.

Studies such as those of Cundiff and his associates have important implications for designing breeding systems to maximize the efficiency of beef production. A breeding system is a means to an end. Once production goals have been selected a breeding system can be chosen which will enable the most rapid achievement of those goals.

Livestock Production Models

The use of mathematical models to examine the behavior of systems has been extensive in engineering and has been formalized in the area of study known as systems analysis. Forrester (1961) proposed a philosophy and a technique for modeling social and economic systems. In recent years much interest has developed in the modeling of livestock production systems with special emphasis on the economic aspects of these systems.

Linear programming (LP) has been a popular tool for modeling livestock production systems. Workers in Texas (Long, 1972; Long, Cartwright, and Fitzhugh, 1975) have pioneered in the development of LP models of beef production systems. They have used these models to study the effects of cow size, milk yield, herd management, heterosis, complimentarity, and mating plan on the efficiency of beef production. Canadian workers (Wilton, Morris, Jenson, Leigh, and Pfeiffer, 1974; Morris and Wilson, 1975) have also used an LP model to assess beef production efficiency. Miller, Brinks and Sutherland (1976) reported the use of an LP model to maximize net returns on a southern Colorado hay

and steer grazing operation. Brodnax (1973) employed an LP model to study the effects of various tenure and tax management strategies on large central Florida beef cattle ranches.

Boyd and Koger (1974a, 1974b, 1975) have addressed the problem of beef production efficiency at both the cow and herd levels using a model written in the DYNAMO programming language. Meadows (1970) at MIT, using this same language, developed a model for the United States swine population and also proposed a similar model for the United States beef cattle population. Halter and Dean (1965) used a DYNAMO model to evaluate the management policies of a California range-feedlot operation under conditions of weather and price uncertainty.

Other models examining certain aspects of livestock production systems have appeared in the literature. Rogers (1971) and Smith (1971) have developed decision models to determine the optimum time for replacing a breeding animal in the cow herd. Dinkel and Dearborn (1972) in South Dakota used a program they called "Simumate" to aid producers in evaluating crossbreeding systems. Hilley and Leman (1976) reported a model to examine the effects of biological variables on reproductive efficiency of swine. This model could also be adapted to handle some economic variables and to determine the effects of certain management changes on returns.

CHAPTER III
EXPERIMENTAL PROCEDURES

Design of Study

This study consisted of three phases:

1) the design and development of computer models of a cow as a system and of a herd;
2) the application of the models to estimate the production efficiency of five breed groups of cattle using production data collected over a nine year period at the University of Florida Beef Research Unit at Gainesville; and
3) the use of the models to evaluate alternative beef production systems for the southeastern United States.

The rationale, assumptions, and documentation for the models are discussed below. The computer model is included in Appendix B.

Description of the Model

Selection of a Modeling Technique

Computer models of real systems have been written in general purpose programming languages such as FORTRAN or PL/1, in pre-packaged programs such as the MPS 360 Linear Program, or in specialized languages such as SIMSCRIPT or GPSS. The DYNAMO computer language (Pugh, 1970) was used to construct the model used in this study.

DYNAMO is a specialized computer language developed at Massachusetts Institute of Technology by J. W. Forrester and associates. The philosophies underlying the genesis of the language and its use to solve problems commonly found in industrial management have been

described by Forrester (1961).

DYNAMO is an easy language to learn. Thus it is possible for an experimenter to write and maintain his own programs. The language is flexible and can handle a large number of variables. DYNAMO programs are efficient and are inexpensive to run, even for large models. DYNAMO compilers are compatible with IBM 360 or 370 systems.

The model used in this study was a deterministic model. In other words, no stochastic (statistical) variables were inserted in the model. Where experimental data were not available, the best available estimates were obtained. In some cases it was necessary to rely solely on the judgment of experienced investigators and producers. The objective of a study such as this one is to approximate certain aspects of a real system as closely as possible. If a researcher is to accomplish this objective, he must be willing to accept some data estimates which may not be well documented or he must be willing to make the necessary assumptions.

Since the model was deterministic and the results have no distributions associated with them, a statistical analysis of the differences between beef production systems was not possible. However, as pointed out by Forrester (1970) it is not the intention of this modeling approach to yield analytical solutions. The real systems are far too complex. Rather, this is an experimental empirical approach in search of more knowledge, and thereby better results but not promising analytical or "optimum" solutions to any question. The major achievements of the technique are to reduce a complex composite of variables into comprehensible terms of significance to the user and to provide information for choosing between specific alternatives faced in making management decisions.

There are two parts to the model used in this study: Model I, the Cow Efficiency Estimator, and Model II, the Herd Efficiency Estimator. Model I computes the TDN requirements for a cow and her calf using variables such as animal weight and gain, seasonal changes in cow weight, cow milk production, physical activity of the animals, and the quality of the feed being consumed. TDN may come from various sources, including pasture, and can be assigned a cost and the amount of TDN from each source determined. Thus, cost for producing an individual cow and calf can be determined. A schematic of Model I is shown in figure 1.

Data on TDN requirements and individual animal costs from Model I are used as input data in Model II, the Herd Efficiency Estimator. In addition, information on cattle prices, fixed costs, pregnancy and calf survival rate, death losses, heifer replacement and culling policies, in Model II. The model will then calculate biological efficiency factors such as TDN per animal or per herd, and beef produced per acre. It will also compute economic efficiency factors such as cost per pound of gain, cost per pound of TDN, cost per pound of beef sold, net returns to the herd, net returns per pound beef sold, or net returns per acre. Model II is diagrammed in figure 2.

The symbols commonly used in DYNAMO models and used in the diagrams of figures 1 and 2 include the following:

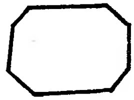
———————— Flow channels for resources

– – – – – – Information flows

Source or sink

Rate equations

Level or stock equation



Auxiliary equations

Level or stock equations represent varying contents of reservoirs of the system. Rate equations define rates of flow between levels of the system. Auxiliary equations are generally used in DYNAMO to reduce the complexity of rate equations by defining the many factors that enter the system. Model I determines cow and calf nutrient requirements. Most of the diagram in figure 1 indicates how the model makes these determinations within each time period. Thus mostly auxiliary equations rather than level or rate equations are used in the model.

Model I: Cow Efficiency Estimator

The model sums the total nutrient requirements of a cow for one year then continues to add to this total the nutrient requirements for carrying her calf from weaning to slaughter. Dollar values are assigned to each unit of TDN consumed. All calculations are made at monthly intervals. The production year for the cow begins when she weans her last calf and ends 12 months later when she weans her current calf.

Cow weight in a given month is determined by the equation

$$COWWT_k = (MCW \times PMCW \times .01) + CG_k) \times CWF_k$$

where

$COWWT_k$ is cow weight in the kth month in kilograms,

MCW is mature cow weight in kilograms,

PMCW is percent mature cow weight attained at beginning of the production year,

CG_k is true cow growth during the kth month in kilograms,

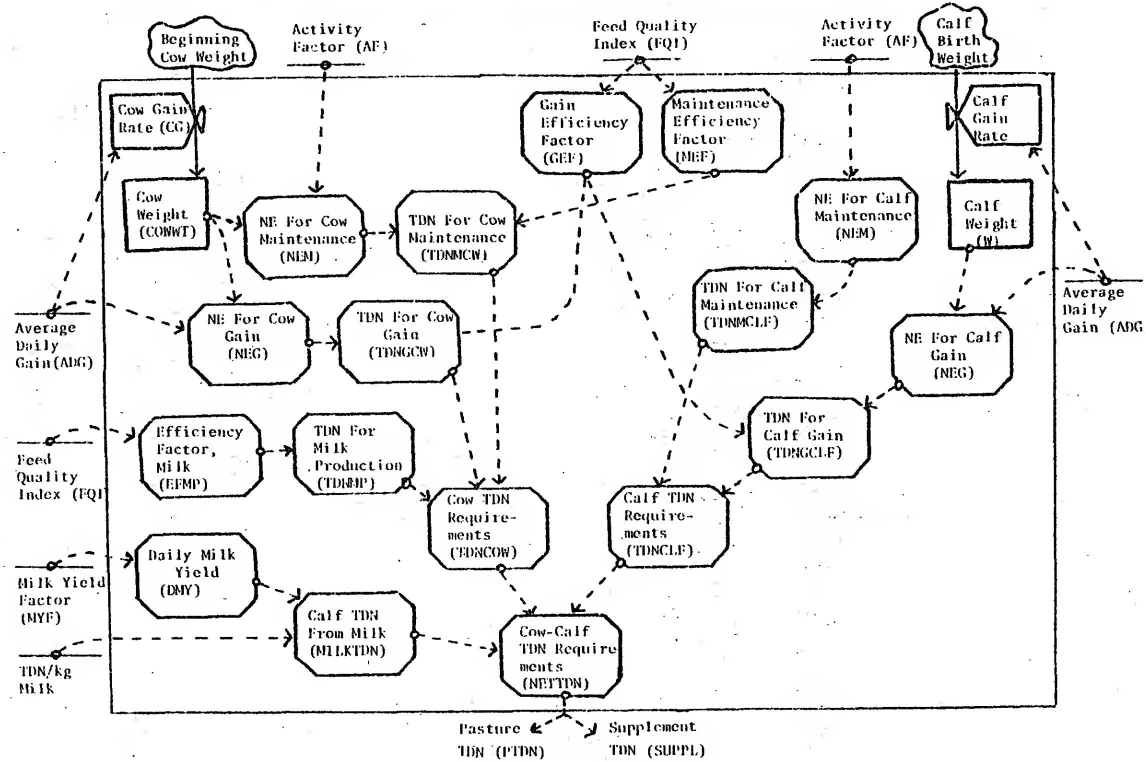


Figure 1. Simplified flow diagram, Model I, Cow Efficiency Estimator.

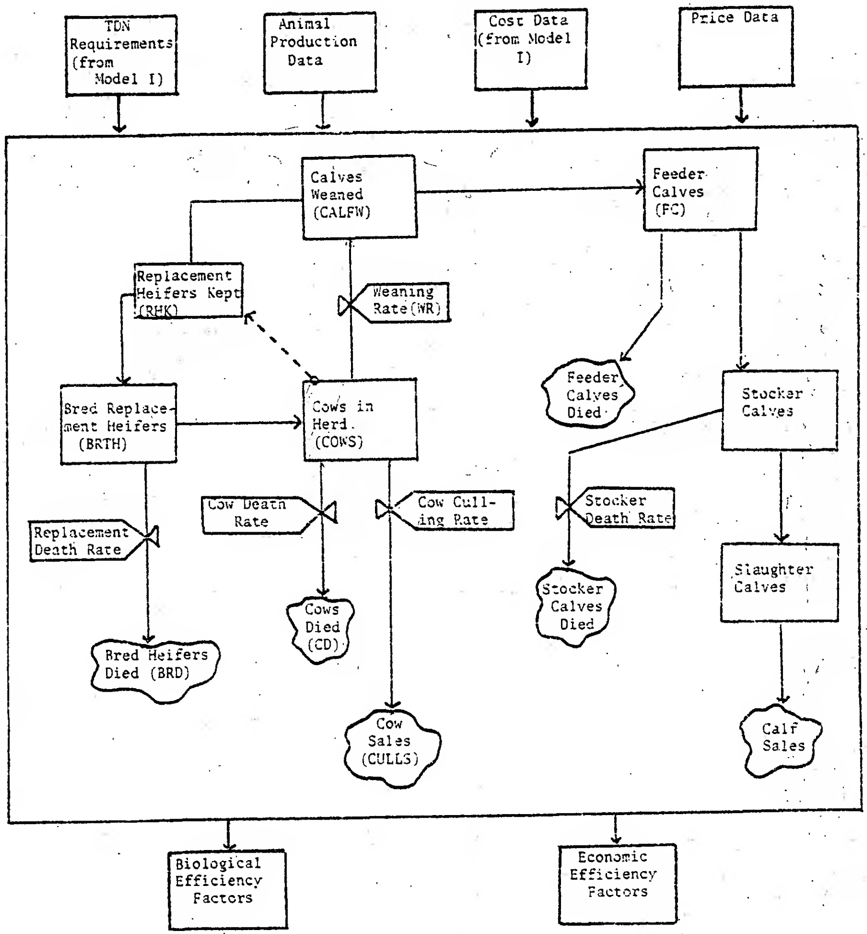


Figure 2. Simplified flow diagram of herd inventory sector, Model II, Herd Efficiency Estimator

CWF_k is a monthly cow weight factor to account for seasonal weight fluctuations.

The gain of a cow which has not reached 100 percent of her mature weight is calculated from her estimated average daily gain over the production year. Seasonal weight fluctuations can be readily changed to suit the environment being modeled simply by changing the monthly cow weight factor (CWF).

Under adequate nutrition, cow milk production reaches a peak during the first or second month of lactation then steadily declines. For the present model the rate of decline in milk production (table 1) was approximated using the data of Dickey (1971) and Rutledge, Robison, Ahlschwede, and Legates (1971). These data also correspond closely to those reported by Melton, Riggs, Nelson, and Cartwright (1967). Daily milk yield is determined as:

$$DMY_k = DMYFM \times MYF_k$$

where

DMY_k is daily milk yield during the kth month,

DMYFM is daily milk yield during the first month of lactation,

MYF_k is the milk yield factor for the kth month as determined from table 1.

Net energy maintenance requirements for cows and calves are calculated from the generally accepted (Crampton and Harris, 1969) formula:

$$NEM = AF \times 0.070 \times W^{0.75}$$

where

NEM is daily net energy for maintenance in megacalories,

AF is an activity factor,

W is animal weight in kilograms.

TABLE 1. MILK YIELD FACTOR.

Month of Lactation	Milk yield factor[1]
1	1.00
2	0.97
3	0.92
4	0.84
5	0.78
6	0.73
7	0.69
8	0.65
9	0.60

[1]Milk yield as a percent of milk yield during the first month of lactation X 0.01.

The activity factor represents the energy cost of incidental activity. According to NRC estimates (NRC, 1970), the activity factor for an animal confined to a feedlot is 1.1. Freden (1970) reviews research indicating that range cows require 49% more energy than housed cattle. This work suggests an activity factor of about 1.6 for range cattle. He also points out that the NRC requirements for dairy cattle (NRC, 1971) are 16% greater than requirements for beef cattle (NRC, 1970) which are presumably on pasture. This increase suggests an activity factor of about 1.25. The activity factor for grazing cows in this model was generally estimated at 1.4.

Net energy for gain of cows is calculated by the same formula used by the NRC (1970) to calculate NEG for heifers.

$$NEG=(0.05603 \text{ X } ADG + 0.01265 \text{ X } ADG^2) \quad (W^{0.75})$$

where

NEG is daily net energy for gain in megacalories,

ADG is average daily gain in kilograms,

W is animal weight in kilograms.

For all calf gains the NRC steer formula for net energy is used:

$$NEG=(0.05272 \text{ X } ADG + 0.0684 \text{ X } ADG^2) \quad (W^{0.75})$$

These net energy computations are made on a monthly basis in the program. All of the variables used in the equations can be changed at monthly intervals.

Because of the wide availability of and ease of determination of TDN values, the most convenient means of expressing nutritional cost is probably cost per unit of TDN. Thus, it is desirable to convert net energy values (a convenient system for expressing nutrient intake in terms of animal weight and gain) to TDN values (a convenient system for assigning costs to each unit of nutrient intake). The disadvantage of

the TDN system is that the efficiency with which a unit of TDN is converted to energy for maintenance, gain, milk production, etc. declines as the quality of the food source declines. For example, a cow requires fewer units of TDN to maintain a constant body weight on a concentrate ration than if grazing a frosted grass pasture.

In theory, net energy requirements for maintenance and gain do not vary with ration quality as do metabolizable energy (ME) or TDN requirements. The NRC (1970) has published efficiency-of-energy-utilization relationships for converting ME to NE. This ME value can be converted to TDN by assuming 3.6155 Mcal of ME/kg of TDN. TDN requirements for maintenance and gain can be calculated from the equations:

$$TDNM=(NEM/MEF)/3.6155$$

$$TDNG=(NEG/GEF)/3.6155$$

where

TDNM is kilograms of total digestible nutrients required for maintenance,

TDNG is kilograms of total digestible nutrients required for gain,

NEM is net energy for gain in megacalories,

NEG is the net energy for gain in megacalories,

MDF_k is the maintenance efficiency factor from figure 3 for month $_k$,

GEF_k is the gain efficiency factor from figure 3 for month $_k$.

Since NEM and NEG are different for cows and calves there is, of course, a different set of equations for determining TDN in each of these two animal types.

The efficiency factors for net energy conversions for maintenance, gain, and milk production are derived from the graphs in figure 3. The

graphs of the relationships for maintenance and gain are adapted from NRC (1970) data. These relationships also correspond closely to that used by the ARC (1965) in England. The efficiency factor is plotted against a hypothetical "Feed Quality Index" (FQI) the values of which range from 1 to 10. A working definition of "Feed Quality Index" is shown in table 2. A "Feed Quality Index" allows the program to make monthly adjustments for feed quality. The selection of the appropriate index value for a particular feed source usually requires some subjective evaluation by the experimenter. The relationships between feed quality, especially forage quality, and the efficiency of ME conversion to NE needs more study by nutritionists. Another possibility suggested by Harris (1973) was to measure feed quality as Mcal ME/kg of dry matter. This is the approach used by the ARC (1965).

If we assume that cow's milk contains 0.156 kg TDN/kg milk (NRC, 1970), then the TDN required daily for lactation can be determined as follows:

TDNMP=DMY X 0.165 X EFMP

where

TDNMP is the kilograms of total digestible nutrients for milk production,

DMY is cow milk yield per day in kilograms

EFMP is the efficiency factor (figure 3) for ME conversion to NE during milk production.

Neville (1971) estimated that Hereford cows on a 40% concentrate ration required 0.30 kg TDN per kg of 3.4% fat corrected milk produced. NRC (1971) estimates for dairy cattle are 0.33 kg TDN per kg of 3.5% fat milk produced. This latter figure represents a conversion efficiency of 51%. To derive the graph for the milk conversion efficiency factor

Figure 3. Assumed relationships between feed quality and efficiency of ME conversion to NE.

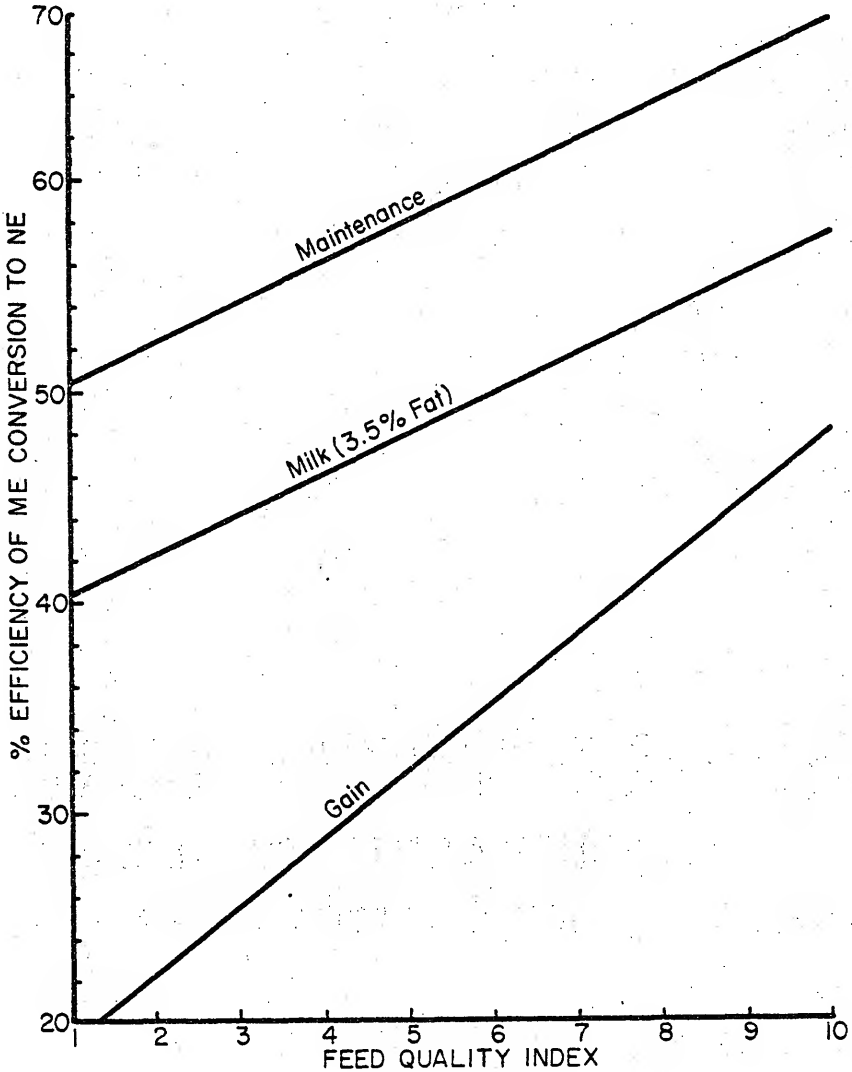

% EFFICIENCY OF ME CONVERSION TO NE
70
60
50
40
30
20
Maintenance
Milk (3.5% Fat)
Gain
1
2
3
4
5
6
7
8
9
10
FEED QUALITY INDEX

TABLE 2. ASSUMED RELATIONSHIPS BETWEEN FEED QUALITY INDEX AND RATION QUALITY.

Feed quality index	Forage rations	Concentrate rations
1		
2	Low quality	
3		No concentrates
4	Medium quality	
5		
6		20% concentrate
7	High quality	40% concentrate
8		60% concentrate
9		80% concentrate
10		Cow's milk

in figure 3, it was assumed that a cow on a 20% concentrate ration is 50% efficient when converting TDN from feedstuffs to milk TDN. This assumption appears consistent with the data cited above. Furthermore, it was assumed that the slope of the milk efficiency curve (figure 3) is the same as that of the maintenance efficiency curve. The major justification for this assumption is that calorimetric studies show metabolizable energy is used with similar degrees of efficiency for both maintenance and milk production in lactating animals (NRC, 1971). The curves published by the ARC (1965) correspond closely to the curves in figure 3.

No provision is made in the model for additional energy due to gestation other than the energy required to maintain the seasonal weight increase, much of which is due to the weight of the fetus and fetal membranes. This assumption is based on the observation of Brody (1945) that there is generally no increase in nutrient intake of mammals during pregnancy. A possible explanation for this phenomenon may be that the mother reduces her activity while pregnant and saves energy for growth of the fetus or that fetal gain is accomplished at the expense of a loss in maternal body tissue.

Using the above relationships one can calculate the daily TDN required by the cow for maintenance, growth, reproduction, and lactation. TDNCOW is determined by:

TDNCOW=TDNMCW + TDMGCW + TDNMP

with TDMCW and TDNGCW coming from NRC equations for heifers as previously described for TDNM and TDNG

TDN requirements for calf maintenance and growth are calculated using the equation:

TDNCLF=TDNMCLF + TDNGCLF

where TDNMCLF and TDNGCLF are derived from NRC equations for steers as described above for TDNM and TDNG.

The net TDN harvest per day by both cow and calf are described as follows:

NETTDN=TDNCOW + TDNCLF - MILKTDN

where

MILKTDN=DMY X 0.156 kg TDN/kg milk,

MILKTDN represents the amount of the calf's TDN requirements met by its dam's milk. DMY is the daily milk yield as described previously. Monthly TDN requirements for cow and calf are determined by multiplying NETTDN by 30.417, the average number of days per month in a non-leap year.

The TDN requirements for cows may be filled either from pasture or from supplement. The TDN available from pasture in the $_k$th month is:

$PTDN_k = AUM_k \times TDN/AUM \times PSR_k$

where

$PTDN_k$ is the available pasture TDN in the $_k$th month,

AUM is the animal unit months of grazing available in the $_k$th month,

TDN/AUM is the TDN assumed to constitute an animal unit month of grazing,

PSR_k is the pasture stocking rate in acres per animal unit during the $_k$th month.

The supplement required during the $_k$th month is:

$SUPPL_k = NETTDN_k - PTDN_k$

where

$NETTDN_k$ is the monthly NETTDN described above.

In calf grazing programs, no provision was made for supplementation. Thus, TDN harvested from grazing is simply TDNM plus TDNG.

Model II: Herd Efficiency Estimator

Model II determines the inventory of all animals that comprise a herd, including brood cows, replacement heifers, weanling calves, stocker calves, and slaughter animals. It provides for death losses and culling of breeding stock. This phase of the model is diagrammed in figure 2.

Using data from Model I, the Herd Efficiency Estimator determines the TDN requirements for the herd and acreage requirements and costs for production of that TDN. It also assigns a value to each animal sold from the herd and computes total herd sales. Thus by using the cost data shown in tables 3, 8, and 10, it is possible to compute net returns for the herd.

The inventory of animals in the herd is determined as follows beginning with the brood cow herd.

$$COWS_k = COWS_j + BRTH_j - CULLS_j - CD_j$$

where

$COWS_k$ is the number of breeding age cows in the present or kth year,

$COWS_j$ is the number of breeding age cows in the herd during the previous or jth year,

$BRTH_j$ is the number of bred replacement heifers transferred to the herd at the end of the jth year,

$CULLS_j$ is the number of cows culled during the jth year,

CD_j is the number of cows which died during the jth year.

CULLS=COWS X (100-WR-CONCR) X .01

where

WR is the weaning rate or the percent of the cow herd weaning calves,

CONCR is a constant culling rate of 5% to allow for the culling of old, sick, crippled, or poor producing cows.

All replacement breeding stock (BRTH) is assumed to be produced in the herd and atstable herd size is determined by:

$BRTH_k = RHK_j = CULLS_j + CD_j + BRD_j$

where

RHK_j is the replacement heifers kept during the previous or the jth year,

CULLS is the number of cows culled,

CD is the number of cows died,

BRD is the number of bred replacement heifer death losses.

This equation is a simplified representation of the equations used when herd size is stabilized. The DYNAMO model used in this study was a modified version of a program used to analyze herd expansion policies and involves a feedback loop to allow for expansion of cow numbers until some specified steady state herd size is reached. In the current study, the herd size was set at 1000 cows and as each new set of data was specified, the program was allowed to run for seven time periods in order to stabilize the animal inventories. This explains the presence of the information feedback loop between "Cow Herd" and "Replacement Heifers Kept" as shown in figure 2.

In allocation of nutrients to replacement heifers, Model II assumes that from 12 to 24 months of age a replacement heifer consumes 80% as much TDN as the mature cow in her same size category. Once they are transferred into the breeding herd and calve at 24 months of age, all cows, regardless of age, are assumed to require the same amount of

nutrients. This assumption is consistent with the data of Cruz (1961) who reported that the nutrient requirements of 800 pound young growing beef heifers during their first lactation were approximately the same as for mature lactating cows weighing 900 to 1100 pounds.

The calves which enter the sale inventory are determined as follows:

FC=CALFW - RHK

where

FC is the number of feeder calves,

CALFW is the number of calves weaned (cows X weaning rate) and,

RHK is the number of calves kept as replacement heifers.

The program allows three options for the sale of calves. They may be sold at weaning, they may be grazed for several months and sold as stockers, or they may be sold at the end of a feedlot phase as fat slaughter cattle.

By using cost and price estimates and information generated by Model I, the Cow Efficiency Estimator (Model II) also determines the TDN requirements, acreage requirements, and net returns for the herd. Most of these calculations are straightforward and can be followed in the program printout shown in Appendix B. The TDN requirements, costs and animal weights for each phase of the production cycle for an individual animal are obtained from Model I and entered as data in Model II. Estimates of cattle prices and TDN production per acre for the different pastures and crops (table 3) are entered directly into Model II. Adjustments are made by the program for early culling of non-pregnant cows and cows which lose calves between pregnancy testing and the end of the calving season.

Sources of Information

The University of Florida Beef Research Unit program was used as a prototype beef production unit for this study. From the program, extensive data were available on cow weight, fertility rates, calf survival, weaning weights, and calf gain. Reliable and comprehensive data on pasture fertilization and stocking rates were also available. The assumptions used in the Beef Research Unit analysis are detailed in Chapter IV.

Data from the Beef Research Unit program also heavily influenced the assumptions used in the Coastal Plains study. Experiment station data from Florida, Georgia, Alabama, and Mississippi were also used in the Coastal Plains assumptions.

Cost and Price Assumptions

Input prices used in the cost budgets are primarily those prices existing at the time the final analyses for this study were done in 1975 and early 1976. Table 3 summarizes costs for pastures and crops. Pasture costs include labor and all equipment costs, including depreciation and repairs. Cost per pound of TDN for each pasture program is determined by dividing the pasture costs (tables 15 - 18, Appendix A) by the TDN harvested by grazing from each acre of pasture. This estimate of grazed TDN is determined by using the animal data outlined in the footnotes of table 3. These data, including stocking rates, are based on numerous experiment station reports from Florida, Alabama, and Georgia and on data from well-managed operations in the same area. The data were used in Model 1 to calculate animal TDN requirements for the periods indicated. Thus by using known animal production response and pasture stocking rates, it was possible to estimate the unit cost

TABLE 3. PRODUCTION RATE AND COST SUMMARY FOR PASTURES AND CROPS

System	Description	Stocking Rate or Yield	TDN/Acre	Cost per Acre	TDN Cost per Lb.
		units/acre	lbs	$	$
I-III	Clover-grass[a]	0.77 Cows	3660	36.78	0.0100
IV	Clover-grass[a]	1.67 Cows	5152	36.78	0.007
II	Ryegrass-Clover-Bermuda[b]	1.75 Yearlings	5518	57.80	0.0105
I	Rye-Ryegrass-Clover[c]	1.75 Yearlings	2452	76.78	0.0313
I	Millet[d]	3.25 Yearlings	3565	73.25	0.0205
I-V	Corn (Silage)[e]	12 Tons	6000	204.00	0.0340
I-V	Corn (Grain)[e]	60 Bushels	2898	120.00	

Footnote.

[a]Based on 1050 lb cow giving 11 lbs milk/day; see table 15 for cost.

[b]Based on yearling with 530 lb initial weight gaining 1.7 lbs/day from February 1-May 31, then 1.3 lbs/day, June 1-September 30; see table 16 for cost.

[c]Based on yearling with 394 lbs initial weight, gaining 1.7 lbs/day, 145 grazing days; see table 17 for cost.

[d]Based on yearling with 569 lb initial weight, gaining 1.3 lbs/day, 100 grazing days; see table 18 for cost.

[e]Based on corn silage at 25% TDN as fed; ground ear corn, 70 lbs/bushel, 69% TDN as fed; see table 19 for cost.

[f]Assumptions for Systems III also apply to Beef Research Unit.

TABLE 4. NON-FEED VARIABLE COSTS ($/YEAR).

Item	Brood Cows		Replacement Heifers		Feeder Yearlings	
Veterinarian and Medicines						
Worming (twice)	3.50		2.00		2.00	
Vibrio Vaccine	0.80		0.80		----	
Other Vaccines	----		1.00		1.50	
Insecticides	0.50		1.00		1.00	
Vet Fees	1.00		1.00		1.00	
Miscellaneous[a]	0.50	6.30	0.50	6.55	1.00	6.50
Minerals						
Minerals	1.00	1.00	1.00	1.00	1.00	1.00
Miscellaneous Expenses		3.00		3.00		3.00
Breeding Costs[b]		10.31		10.31		
TOTAL NON-FEED COSTS		20.61		20.86		10.50 or 0.88/Mo.

[a]Branding, tagging, weighing, etc.

[b]From table 20.

[c]Heifers in Coastal Plains Systems III-V are assumed to consume as a pasture supplement 1000 lbs/year (5 lbs/day for 200 days) of Ration A, table 19 at a cost of $49.01.

TABLE 5. CATTLE PRICE STRUCTURE AND PRICE ASSUMPTIONS.

	Weight Range[a] lbs	High-High[b] $/lb	High-Low[c] $/lb	Low-High[d] $/lb
Calves				
At Weaning	324-592	0.50	0.50	0.32
At Feedlot	792-1101	0.50	0.40	0.44
At Slaughter	896-1161	0.50	0.39	0.50
Cull Cows	850-1200	0.33	0.33	0.33

[a] See table 10.

[b] Calf prices high at weaning, high at slaughter. (This is the only price structure examined for the Beef Research Unit data.)

[c] Calf prices high at weaning, low at slaughter.

[d] Calf prices low at weaning, high at slaughter.

of TDN for use in subsequent models to compare animals of different production characteristics.

The costs of mixed rations are shown in table 19 (Appendix A). The NRC (1970) TDN values for the ration ingredients were used to determine TDN costs. Breeding costs are shown in table 20 (Appendix A) and variable costs for non-feed items are included in table 4.

It is important to note that no interest charges, land rent, or overhead items are included in the analysis done here. Such costs can vary tremendously between operations and are not essential to the comparisons which were made in this study. Consequently, they were omitted. A list of common overhead items is shown in table 40, Appendix A. The effect of their inclusion in analyses is discussed in Chapter V.

Cattle prices were varied in this study. The price ranges used here and shown in table 5 were selected so as to be consistent, not only with historical market behavior, but also with cost assumptions. In other words, these prices would allow a rational producer of sufficient size and management ability to make an acceptable return on his investment.

CHAPTER IV
ANALYSIS OF BEEF RESEARCH UNIT DATA FROM
FIVE BREED GROUPS

Data from the University of Florida Beef Research Unit near Gainesville provided a means of comparing the production efficiency of five breed groups of cattle of different size, milk yield, growth rate, fertility level, and carcass composition. Data from the five breed groups were analyzed using the two computer models described in Chapter III. Various measures of production efficiency were determined at weaning and at slaughter. The measures of production efficiency included pounds of beef per acre, pounds of TDN per pound of beef produced, cost per pound of beef produced, net returns per 1000-cow herd, net returns per pound of beef sold, and net returns per acre.

Beef Research Unit Data and Assumptions

The Beef Research Unit project at the University of Florida was unique in that the foundation females were typical of the commercial cattle in Florida during the late 1940's and early 1950's. Five breeding systems were compared for improving productivity on clover-grass pastures. The systems included: 1) upgrading to Angus, 2) upgrading to Hereford, 3) Hereford-Angus crisscross, 4) Brahman-Angus crisscross and 4) Hereford-Santa Gertrudis Crisscross. The sires used in the program came mostly from the USDA Beef Cattle Research Station at Brooksville, Florida. They were top sale bulls, were used one or

two years, and then returned to Brooksville. As representatives of their respective breeds, the bulls were of better than average growth potential and came from the better milking dams that have been culled rigorously for reproductive failure.

For a period of five years, beginning in 1952, the foundation females were mated to bulls of four breeds including Angus, Brahman, Hereford, and Shorthorn. At the end of this period (1957) the young females were assigned to the systems indicated above on the basis of breed composition to move the program along as rapidly as possible.

The breeding season initially was restricted to a period of 90 days beginning in early March. The length of the season was gradually shortened to 65 days by 1965.

In the BRU model the average calving data was set at January 1 and the average weaning data at September 30. Cows were palpated for pregnancy at weaning with all nonpregnant cows being culled from the herd. In addition, cows whose calves died before weaning were culled along with an assumed 5% of the lower producing cows. All cull cows were replaced with pregnant heifers. Steer calves were placed in the feedlot at weaning and fed for a period of 180 days to an average USDA grade of high good. For the purposes of this study, it was assumed that surplus heifers were fed also.

Initially heifers were bred to calve first at three years of age. Beginning with the 1958 calf crop, one-half of the heifers were bred to calve at two years of age and one-half bred to calve at three years of age. This practice was continued until 1968 after which all heifers were bred first as yearlings. Calving at two years was assumed in this analysis. None of the calves were creep-fed when with the cow.

The period covered by the present report was the last nine years of the trial (1964-1972). The data from all age groups of dams (2 years and older) are included. Average production performance for the period was adversely affected by disastrous flooding during one calving season which lowered survival rate of calves during that year and calving rate during the following year.

The cattle were maintained on clover-grass pastures for approximately nine months. During the winter months, cows were fed a corn silage ration with a protein supplement. Since the herd was dispersed before milk yield data was obtained for each group, milk yields were estimated using relative weaning weights and data from equivalent breed groups under similar conditions. Steer calves were placed in a feedlot immediately after weaning and fed for approximately 180 days on a moderately high energy ration. For this study, feed prices were based on a ground ear corn ration. Cows were weighed every three months. Weaning weights were obtained about August 20 although calves were usually not separated from their dams until late September. All steers were weighed prior to slaughter. The assumptions used in the Beef Research Unit analysis were:

1) Gain of the average cow in the herd was 36.5 lbs/year.
2) Average birth weight of all calves was 65 lbs.
3) The Feed Quality Index Indices from January through December were, respectively, 5, 5, 7, 7, 7, 5, 5, 4, 3.5. 3.5, 3, and 5 for cows.
4). Pasture production capacities from January through December were, respecitvely, 0.0, 0.6, 0.9, 1.0, 1.1, 1.2, 1.2, 1.0, 0.8, 0.4, 0.0, 0.0 AUM's of grazing.
5) One animal unit month (AUM) of grazing supplied 600 lbs TDN in grazed forage, where an AUM is the monthly requirements of a 1050

lb cow giving 11.0 lbs milk/day to a 350 lb calf.

6) The cow weight factors (factors by which mature cow weight was multiplied) from January through December were, respectively 1.10, 1.00, 0.95, 0.96, 0.97, 0.98, 0.99, 1.00, 1.02, 1.04, 1.07, and 1.09.

7) Replacement heifers were supplemented for 200 days with 5 lbs/day of Ration A (table 19, Appendix A) and consumed 80% as much pasture TDN as their mature dam.

8) Death loss rates were 2% for cows, 1% for feedlot yearlings, and 1.5% for replacement heifers.

9) The activity factor was 1.4 for cows and calves on pasture and 1.1 for calves in the feedlot.

10) Pasture costs and TDN production were as shown in table 3.

11) Pasture stocking rates were 1.3 acres per animal unit.

12) Nutrient requirements not fulfilled by grazing were supplied with a corn silage ration supplemented with protein (table 19, Appendix A).

13) Feed costs were $.010/lb TDN consumed from pastures, $.039/lb TDN for the cow wintering ration, and $.069/lb TDN for the feedlot ration (tables 3 and 19).

14) Animal non-feed costs were $20.61/year per cow and $20.86/year per replacement heifer, including breeding costs, veterinary expenses, medicine, and minerals (table 4).

15) Non-feed costs for animals in the feedlot were $0.88/month.

16) The value of calves sold was $0.50/lb at weaning and at slaughter; cull cows sold for $0.33/lb.

Production data for five breed groups were assembled by taking the simple average of data collected from 1964 through 1972 at the Univer-

TABLE 6. ANIMAL PRODUCTION CHARACTERISTICS AND COST-PRICE ASSUMPTIONS, BEEF RESEARCH UNIT DATA.

Item	Straightbreds			Crossbreeds		
	Average	Angus	Hereford	Angus-Hereford	Angus-Brahman	Hereford-S. Gertrudis
Brood Cows						
Mature Cow Weight (Lbs)	1047	956	1097	1035	1032	1094
Daily Milk Yield (Lbs)	12	11	12	11.5	12	12.75
% Pregnancy	89.9	88.5	90.5	93.2	90.0	86.6
% Calf Survival	92.7	95.5	90.4	93.5	91.6	92.9
Weaning %	83.3	84.5	81.8	87.1	82.3	80.2
Cow-calf Maintenance Costs ($)[a]	123.78	113.70	128.45	121.95	123.41	130.07
Weanling Calves						
Weaning Weight, 9 Mo (Lbs)	556	503	573	547	568	594
Grade[b]	10.9	11.1	11.0	11.0	10.8	10.7
Live Weight Value ($/Cwt)[c]	49.20	49.46	49.33	49.33	49.07	48.93
Slaughter Yearlings						
Feedlot Gain (Lbs/day)	2.07	1.85	2.09	2.11	2.10	2.11
Cost/Cwt Gain[d]	41.39	40.45	41.97	40.83	41.72	42.74
Slaughter Weight, 15 Mo (Lbs)	917	830	937	911	934	960
Grade[b]	11.0	11.7	10.6	11.5	10.9	10.3
Dressing %	60.9	60.5	60.4	60.5	62.0	60.5
Value of Carcass ($/Cwt)[e]	81.33	82.26	80.80	81.93	81.20	80.40
Live Weight Value ($/Cwt)[f]	49.53	49.77	48.80	49.57	50.34	48.60

[a]Adjusted by simulation program (Model I) for cow weight, milk yield and calf weight and gain.
[b]Choice = 13, Good = 10.
[c]Choice steers @ $52.00/Cwt, Good steers @ $48.00/Cwt.
[d]Estimated by simulation program.
[e]Choice @ $84.00/Cwt, Good @ $80.00/Cwt.
[f]Calculated from carcass value and dressing %.

sity of Florida Beef Research Unit. Table 6 shows the data used in the analysis.

Results of Beef Research Unit Analysis

Biological Components

Measures of biological efficiency for herds of the five breed groups of Beef Research Unit cattle are shown in table 7. In spite of a wide variety of cow sizes, milk yields, and fertility levels, there is very little difference in the indicators of biological efficiency examined here.

The average of each measure of production efficiency was assigned a value of 1.0 and used as the basis of indexing the data from each breed group. These index values are shown in parentheses in table 7. In no case did the difference between any two breed groups exceed 3.5%.

Economic Components

Several measures of economic efficiency are shown in table 8. The breed groups showed only minor differences in cost per pound of beef sold. However, the profit components did indicate some differences.

The highly fertile Angus-Hereford cross ranked first in all three measures of profitability. In general, the straightbred Angus ranked second (except in net returns per 1000-cow herd), the Angus-Brahman cross third, the straightbred Hereford fourth, and the Hereford-Santa Gertrudis cross last.

What were the production factors (table 16) influencing these rankings? Cow size seemed to show no relationship to profitability, except that it lowered the rank of the small Angus cattle, especially at weaning, in net returns per 1000-cow herd. This measure of returns, however, is probably not a very good indicator of economic efficiency

TABLE 7. MEASURES OF PRODUCTION EFFICIENCY, BIOLOGICAL COMPONENTS, BEEF RESEARCH UNIT DATA.

Item	Average	Straightbreds		Crossbreeds		
		Angus	Hereford	Angus-Hereford	Angus-Brahman	Hereford-S. Gertrudis
LBS TDN/LB BEEF SOLD						
At Weaning	11.49 (1.000)[a]	11.50 (1.001)	11.56 (1.006)	11.49 (1.000)	11.48 (0.999)	11.37 (0.990)
At Slaughter	9.96 (1.000)	9.88 (0.992)	10.12 (1.016)	9.77 (0.981)	9.99 (1.003)	10.08 (1.012)
LBS BEEF SOLD/ACRE						
At Weaning	357.1 (1.000)	355.6 (0.996)	356.3 (0.998)	354.4 (0.992)	357.5 (1.001)	362.9 (1.016)
At Slaughter	375.3 (1.000)	376.7 (1.004)	371.3 (0.989)	380.4 (1.014)	374.0 (0.997)	373.3 (0.995)

[a]Values in parentheses are indexed against the average value for that item.

TABLE 8. MEASURES OF PRODUCTION EFFICIENCY, ECONOMIC COMPONENTS, BEEF RESEARCH UNIT DATA. ($)

		Straightbreds		Crossbreeds		
Item	Average	Angus	Hereford	Angus-Hereford	Angus-Brahman	Hereford-S. Gertrudis
COST/LB BEEF SOLD						
At Weaning	.2558	.2560	.2593	.2508	.2560	.2568
	(1.000)	(1.001)	(1.014)	(0.980)	(1.001)	(1.004)
At Slaughter	.3007	.2993	.3023	.3003	.3008	.3001
	(1.000)	(0.995)	(1.005)	(0.999)	(1.000)	(0.998)
NET RETURNS/1000 COW HERD						
At Weaning	94,730	88,550	93,380	103,220	98,675	93,190
	(1.000)	(1.042)	(0.920)	(1.074)	(1.027)	(0.902)
At Slaughter	111,440	106,590	103,950	123,445	114,220	101,885
	(1.000)	(1.042)	(0.920)	(1.074)	(1.027)	(0.902)
NET RETURNS/LB BEEF SOLD						
At Weaning	.1702	.1750	.1619	.1875	.1675	.1597
	(1.000)	(0.935)	(0.986)	(1.090)	(0.989)	(0.984)
At Slaughter	.1456	.1517	.1339	.1564	.1496	.1314
	(1.000)	(0.956)	(0.933)	(1.108)	(1.025)	(0.914)
NET RETURNS/ACRE						
At Weaning	60.78	62.21	57.71	66.64	59.92	57.74
	(1.000)	(1.024)	(0.949)	(1.096)	(0.986)	(0.950)
At Slaughter	68.97	71.35	63.28	74.69	69.95	62.41
	(1.000)	(1.037)	(0.920)	(1.086)	(1.017)	(0.907)

[a] Values in parentheses are indexed against the average value for that item.

since most producers are likely to be constrained by land rather than by cow numbers. The best measures of profitability, net returns per pound of beef sold and especially net returns per acre, did not appear to indicate any relationship between cow size and profitability.

Note that cost per pound of beef sold was approximately the same for all breed groups. Thus differences in profitability must have been due to factors which affect income rather than factors affecting costs.

Income per pound of beef sold was influenced by the value of the calf -- primarily carcass quality and dressing percent. Table 6 shows that that Angus and Angus-Hereford crosses had the highest carcass value chiefly due to their higher carcass grade. Income per pound of beef sold was also higher in a herd where most of the beef came from calf sales rather than from low-priced cull cows. Consequently, herds with high fertility levels would have fewer cull cow sales and more calf sales. This seemed to be the primary factor affecting net returns per pound and net returns per acre. In these two measures of profitability the breed groups ranked almost exactly as they ranked in weaning percent (table 16).

In summary, the net returns per acre for the Angus-Hereford cross were 9.6% higher at weaning and 8.6% higher at slaughter than the average of the five breed groups. The Angus-Hereford cross had a 7.2% advantage at weaning and a 4.9% advantage at slaughter over its nearest competitor, the straightbred Angus. Most of the differences in profitability between breed groups appeared to be due to fertility levels.

CHAPTER V
ANALYSIS OF BEEF CATTLE MANAGEMENT SYSTEMS FOR THE COASTAL PLAINS

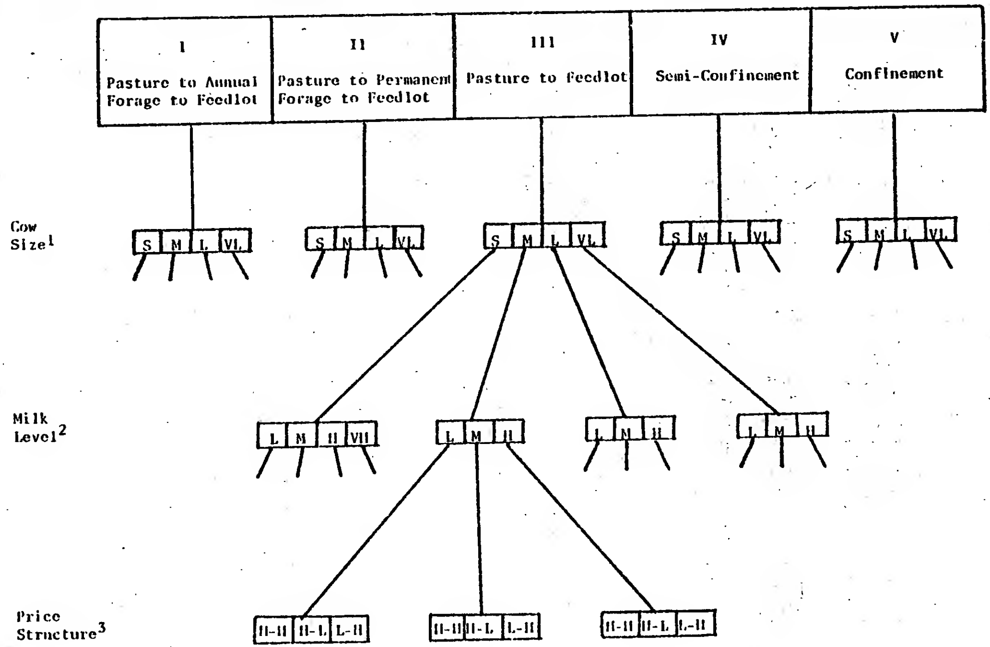
The ultimate objective of this work was to compare alternative systems of beef production in the Coastal Plains of the southeastern United States. The general design of the Coastal Plains beef study is illustrated in figure 4. Five hypothetical forage production and feeding systems were selected for study. Animals with different assumed production characteristics were examined within each forage and feeding system. Finally, the effects of three market conditions were evaluated for all combinations of forage feeding systems and animal production characteristics.

Coastal Plains Data and Assumptions

Forage and Feeding Systems

The five hypothetical forage and feeding systems analyzed here and the characteristics assumed for each system are described below.

System I: pasture to annual forage to feedlot. After separation from their calves on September 30, cows were assumed to graze on surplus grass during October and November. From December through February they were fed a silage ration. From March through May, which included the breeding season, pastures were predominantly clover. The clover went dormant in early June and cows grazed primarily grass until the end of the production year in September. After weaning, calves received a corn silage ration during October and November and gained



[1]Cow size: S=small, M=medium, L=large, VL=very large.

[2]Milk level: L=low, M=moderate, H=high, VH=very high.

[3]Price structure: H-H=high at weaning-high at slaughter, H-L=high at weaning-low at slaughter, L-H=low at weaning-high at slaughter.

Figure 4. Design of Coastal Plains beef modeling study.

0.3 lbs/day. From December through May, calves were grazing a rye-ryegrass-clover pasture on which they gained 1.5-1.8 lbs/day. Gains here were dependent on growth potential as reflected in cow size. From June through September, calves gained 1.2-1.5 lbs/day on millet. They were then placed on a feedlot ration (table 19, Appendix A) for 60 days and gain 2.2-2.5 lbs/day. System I is presently a popular system of beef production in the southeastern United States.

System II: perennial pasture to topseeded perennial grass to feedlot. Brood cows in this system were handled exactly as assumed in System I. Calves were placed on a corn silage ration (table 19, Appendix A) after weaning, from October through January. They were assumed to gain 0.3 lbs/day during their first two months on this ration then 0.9-1.2 lbs/day during December and January. In February through May they gained 1.5-1.8 lbs/day, the same as in System I. From June through September, calves remained on these pastures, which were now predominantly Coastcross bermuda grass, and gained 1.1-1.4 lbs/day. After leaving Coastcross bermuda pastures at the of September, calves were placed in the feedlot for 60 days where they gained 2.2-2.5 lbs/day. Such a program as System II is not now commonly practiced in the southeastern United States. However, recent work by Utley, Marchant, and McCormick (1976) in Georgia suggests that such a program is feasible.

System III: perennial pasture to feedlot. Cows were managed and fed exactly as assumed in Systems I and II. The calves were placed in the feedlot immediately after weaning, where they were assumed to gain 0.5 lbs/day during their first month there. Gains then increased to 2.3-2.6 lbs/day from November through May. The total feeding period was 240 days. These animals weighted slightly less at slaughter than

those in Systems I and II. Programs such as System III have been popular systems in the past, though the cow-calf operations and the feedlot phase usually occur at separate locations with calves under different ownership. This system was employed at the University of Florida Beef Research Unit.

System IV: drylot/perennial pasture to feedlot. This is a semi-confinement system with brood cows maintained on limited pasture and in a drylot when pasture is inadequate or not available, and with weaned calves going directly into the feedlot. Simulation runs of Model I indicated that, during most months, much more forage was available then was consumed by the cattle. Actually, much of the forage in the late summer and fall months was forage which had accumulated during rapid summer growth. In an attempt to utilize forage more efficiently, the effect of increasing the stocking rate more than two-fold to 1.67 animals units/acre was simulated. At this stocking rate, all or nearly all of the forage produced during June, July, and August was utilized with little or no supplementation required. To allow for reduced grazing activity, the activity factor was reduced from 1.4 to 1.25. Note in table 3 the increase in TDN/acre in the same type pasture with an increased stocking rate. This increase in TDN/acre occured primarily because forage was grazed at its most nutritious stage when it had its maximum TDN value for the animals. TDN yields were probably also enhanced by a reduction in waste and trampling. Cows in this system were managed the same as assumed in Systems I through III except that they received a corn silage supplement when pastures were inadequate to meet their needs. Calves were placed in the feedlot after weaning and gained exactly as assumed in System III.

System V: drylot to feedlot. Brood cows in System V were assumed to be confined exclusively in a drylot where they were fed a corn silage ration (table 19, Appendix A). After weaning on September 30, calves were placed in a feedlot and were assumed to gain exactly as those in Systems III and IV. The activity factor for all animals, including brood cows, was 1.1.

Note that Systems I and II involve a stocker phase in which calves are grazed on a forage between weaning and the feedlot. In Systems III through V, calves are weaned from their dams and placed directly into a feedlot.

Animals Production Characteristics

The major animal production characteristics used in the study are outlined below. The assumed values for each characteristic are shown in table 9.

Cow size

Because of the great variations in cow weight due to factors such as season and pregnancy status, weight alone may not be a good indicator of cow size. It is obvious, nevertheless, that if pregnancy status and condition, which are usually associated with season, are held constant, then weight would be a good measure of cow size. The cow weight factor in table 21 (Appendix A) is an attempt to allow for seasonal weight changes caused by factors such as pregnancy status and body condition. If the cow weight factor accounts for environmental variation in weights then the cow weights shown in table 8 would reflect mature genetic cow size. These weights were selected to approximate different cow sizes commonly found in the southeastern United States. The weights fall within the ranges reported by Warwick (1971) for British-type cows.

TABLE 9. PRODUCTION CHARACTERISTICS OF COWS AND CALVES, COASTAL PLAINS DATA.

Mature Cow Wt.	Milk Yield[a]	Calf Birth Wt.	Gain[b] Birth to Weaning	In Feedlot[c]	Pregnancy Rate	Calf Survival
lbs	lbs/day	lbs	lbs/day	lbs/day	%	%
850	7	55	1.1	2.2	92	95
850	9	55	1.3	2.2	91	95
850	11	55	1.5	2.2	90	95
850	13	55	1.7	2.2	89	95
950	8	62	1.4	2.3	93	95
950	10	62	1.6	2.3	92	95
950	12	62	1.8	2.3	91	95
1050	9	70	1.5	2.4	89	95
1050	11	70	1.7	2.4	88	95
1050	13	70	1.9	2.4	87	95
1200	10	80	1.6	2.5	84	95
1200	12.5	80	1.9	2.5	82	95
1200	15	80	2.1	2.5	80	95

[a]Milk yield during first month of lactation.

[b]See text for interim gains between weaning and feedlot.

[c]Gains for Systems I-II; add 0.1 lbs/day for Systems III-V.

As shown in table 9, cows were grouped into four size categories -- "small," "medium," "large," and "very large." These groupings were intended to represent the genetic size of the cow and, as such, influenced the growth potential of that cow's calf. Cow size was an independent variable in the study.

Birth weights were assumed to be proportional to cow size. Calf birth weights were 6.5% to 7.0% of dam weight.

Milk yield

In this study milk yield was assumed to vary with stage of lactation and cow size. The decline in milk yield during lactation has been reported by Dickey (1971); Rutledge, Robison, Ahlschwede, and Legates (1971); and Melton, Riggs, Nelson, and Cartwright (1967). Data from the first two studies were used to estimate the rate of decline in milk yield assumed in this study and shown in table 1.

While the relationship of milk yield to cow size is well recognized in dairy cattle (Preston and Willis, 1970), the relationship between body size and milk yield in beef cattle has not been studied critically. It is reasonable, however, to believe that the positive relationship between cow size and milk yield would apply in beef cattle also. Such a positive relationship is assumed in this study. The assumed average daily milk yields for the entire 8 month lactation ranged from 5.7 to 12.1 lbs/day and are consistent with those yields reviewed in Chapter II. Assumed milk yields during the first month of lactation are shown in table 9. They represent milking levels of "low," "moderate," and "high," including a "very high" level for "small" cows only. Milk yield in this study was an independent variable within each cow size grouping but was assumed to be somewhat dependent on cow size.

Fertility rates

Pregnancy rates used in this study are shown in table 9. Note that pregnancy rate varied with both cow size and milk yield. The effects of increased milk production in lowering reproductive performance has been recognized by animal husbandman (Willham, 1972).

The assumed relationship between cow size and pregnancy rate is also consistent with the views of animal husbandmen in the southeastern United States but is more difficult to defend. The most fertile size group, the 950 pound group, would be representative of the highly fertile Angus-Hereford cross. The smallest 850 pound group would most likely include a small straight-bred Angus herd, or perhaps an Angus-Jersey cross at the highest milk level in this group, and would generally not be as fertile as the Angus-Hereford cross. As cattle get larger, in the 1050-and 1200-pound groups, they tend to become less fertile. Butts (1972) cites data supporting this assumption.

In this study, pregnancy rate was a variable which depended on both cow size and milk yield. Calf survival was assumed constant across all production characteristics and forage-feeding systems.

Calf gain

Calf gains are summarized in table 9 and were detailed previously in the description of forage and feeding systems. Pre-weaning gains were assumed to be correlated with cow size and milk yield. The positive effects of milk yield on weaning weight are well documented.

Research by Gifford (1949), Gifford (1953), and Drewry, Brown and Honea (1959) has suggested that calf size and gains influence milk yield. Thus, if calf gains and milk yield are positively correlated and if calf gains and milk yield as positively correlated and if calf gains are positively correlated with cow size, as assumed here and

suggested by Cartwright (1970), then it logically follows that cow size and milk yield are positively correlated. Such a positive correlation between cow size and milk yield has been assumed above.

Weaning weight was assumed to be approximately proportional to cow size, thus implying a simularly shaped growth curve for all cow sizes up to weaning. Slaughter weights, however, did not increase in proportion to cow size, implying that, after weaning, large cattle tended to mature more slowly than smaller cattle. While difficult to document, this assumption seems consistent with field observations. Furthermore, if this assumption were not invoked, slaughter weights of large calves which showed the same calf weight to cow weight ratios as those of small calves would be unrealistically high.

Market characteristics

A major goal of this study was to present comparisons of alternative beef production systems which would be meaningful and useful to beef producers. Since most beef producers are motivated by profit, the profitability of these alternative beef systems must be compared. The production model used here is designed to estimate costs for the different systems. Determining profits, however, requires an estimate of the market value of the animal. Since beef prices are highly variable, it was necessary to make some assumptions that would allow the comparison of beef system profitability over a wide range of market conditions.

First it was assumed that beef prices will generally exceed production costs and be maintained at a level that will provide producers with an incentive to remain in the beef cattle business. Next, in order that profitability at various stages of the calf's life cycle could be assessed, three historically evident price structures were

evaluated.

High-high price structure. Under this price structure, prices were high at weaning and remained high until slaughter.

High-low price structure. This price structure resulted in high prices at weaning but low prices at slaughter. Such a situation existed with calves weaned in the fall of 1973. Since such calves will usually be sold later at a loss -- a loss not anticipated at the time of purchase -- it is apparent this price structure will be short-lived when it does exist.

Low-high price structure. This price structure, with low prices at weaning and high prices at slaughter existed through most of 1974 and 1975. It is most likely to occur during parts of the liquidation phase of the cattle cycle.

Figure 5 gives a hypothetical illustration of these three price structures and their relationship to an estimated cost of gain curve. The prices assumed in the study were shown in table 5.

General assumptions

For the Coastal Plains analyses, the production year was assumed to start on October 1 immediately after weaning. At weaning time, all cows were pregnancy tested and those which were not pregnant were culled. Also, at this time, an additional 5% of the herd, including cows which were sick, crippled, old, or very poor producers were culled.

A 90-day breeding season beginning in mid-March was used. The average calving date was assumed to be February 1 and weaning occurred eight month later on September 30.

All heifers were bred to calve at two years. In Systems I and II, heifers were managed as stocker calves from weaning until the bred heifers were transferred into the brood cow herd at two years of age.

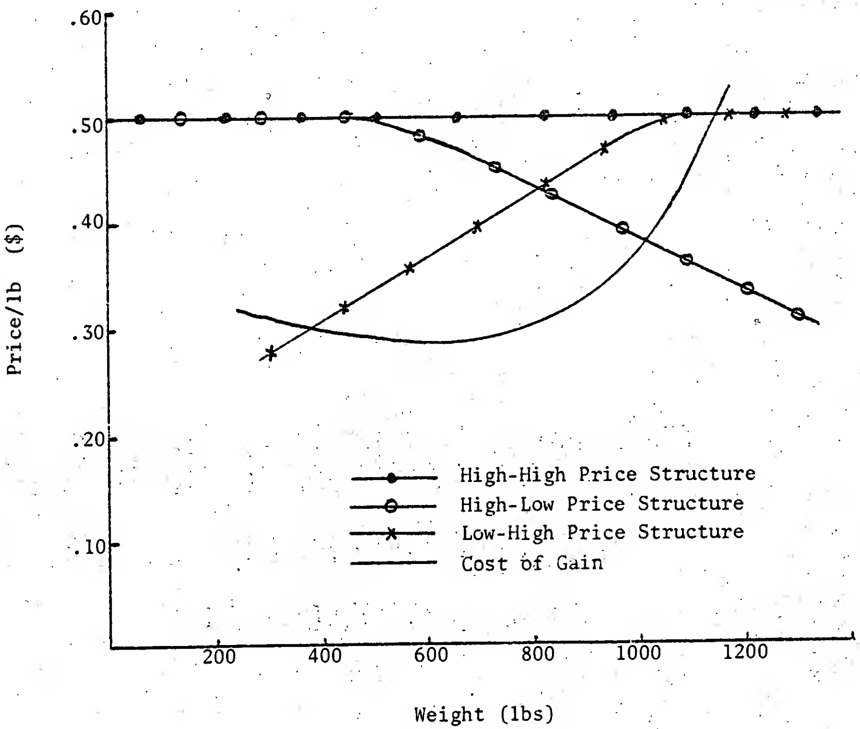


Figure 5. Hypothetical price-cost curve for three price structure.

In Systems III and IV, heifers held for breeding were transferred into the brood cow herd when they were weaned. From this time until they were two years old, it was assumed that they consumed 80% as much TDN as mature cows plus received a supplement of Ration A (table 19, Appendix A) at the rate of 5 lbs/day for 200 days out of the year. Surplus heifers not held for breeding were fed out along with the steers. All animals within each system were slaughtered at the same time. Thus, slaughter occurred at an age-constant rather than a weight-constant basis.

The cow weights shown in table 9 were assumed to represent mature genetic cow size. There was no cow gain other than the seasonal weight fluctuations indicated by the cow weight factors in table 21 (Appendix A).

The following are additional general assumptions:

1) An animal unit month (AUM) of grazing supplied 600 lbs of grazable TDN; where an AUM is the monthly requirements of a 1050 lb cow giving 11 lbs of milk/day to a 350 lb calf.

2) The nutrient requirements of the cow not furnished by grazing were supplied by the corn silage ration shown in table 19 (Appendix A).

3) Feed costs are shown in table 3 and non-feed costs in table 6.

4) Annual death losses were 2% for cows, 1% for yearlings, and 1.5% for replacement heifers.

5) The activity factor was 1.1 for calves in the feedlot. It was 1.4 for grazing animals in Systems I through III, 1.25 in System IV and 1.1 in System V.

6) Pasture costs and TDN production are summarized in table 3,

feedlot ration composition and costs are shown in table 19 (Appendix A).

7) The market value of calves and cows is outlined in table 5.

Additional assumptions and the systems to which these assumptions apply are summarized in table 21 (Appendix A). Cow weight factor is the factor by which the mature cow weight shown in table 9 is multiplied to simulate seasonal weight fluctuations. A stocker supplement factor equal to one indicates that stocker calves are fed a corn silage ration during that month. Uses of the feed quality index for both cows and stockers have been described previously (Chapter III). TDN costs for various pasture programs and rations have been developed in table 3. The other items in table 21 are self-explanatory.

Results of Coastal Plains Analysis

The assumptions outlined above were used as input data for the two simulation models in the manner described in Chapter III. Since the results included both biological and economic components they have been reported here as biological, cost, and profit components.

Results have been reported by cow size, milk level, and feeding system. Estimates were included for three stages of calf development -- at weaning time, at the end of the stocker phase (System I and II only), and at slaughter when the feedlot phase was complete.

Biological Components

The biological components of major interest include acreage requirements for a 1000-cow herd, pounds of beef sold per acre, and pounds of TDN per pound of beef sold. The high and low values of these items for each forage and feeding system are shown in table 10. Additional biological components are also included in table 10. Table 10

TABLE 10. VALUE RANGES FOR FIVE SYSTEMS, BIOLOGICAL COMPONENTS.

	SYSTEM									
	I		II		III		IV		V	
	Low	High	Low	High	Low	High	Low	High	Low	High
CALF WEIGHTS (LBS)										
At Weaning	324	592	324	592	324	592	324	592	324	592
At Feedlot	762	1122	732	1101						
At Slaughter	896	1274	866	1253	829	1161	829	1161	829	1161
LBS TDN/ANIMAL										
To Weaning	4437	6562	4437	6562	4437	6562	3967	5953	3589	5437
Stocker Phase	3457	5246	3342	5197						
In Feedlot	813	1152	792	1136	2384	3494	2384	3494	2384	3494
TDN/LB BEEF PRODUCED (LBS)										
At Weaning	10.54	12.09	10.52	12.03	10.53	12.14	9.34	10.85	8.71	9.82
At Feedlot	10.14	10.46	10.23	10.39						
At Slaughter	9.75	10.19	9.86	10.25	8.61	9.29	7.94	8.57	7.39	8.01
TDN CONSUMED BY HERD (TONS)										
At Weaning	2222	3225	2211	3217	2251	3225	1995	2916	1805	2672
At Feedlot	3377	4381	3328	4363						
At Slaughter	3649	4635	3592	4613	3028	3995	2792	3686	2602	3442
ACRES/1000 COW HERD										
To Weaning	1107.4	1555.9	1087.9	1515.9	1115.5	1589.5	712.9	1020.2	578.8	854.6
To Feedlot	1570.8	2019.6	1484.9	1922.6						
To Slaughter	1758.3	2201.9	1667.5	2098.4	1712.6	2195.8	1310.0	1629.8	1175.9	1471.0
To Slaughter (Buy Grain)	1570.8	2019.6	1484.9	1922.6	1115.5	1589.5	712.9	1020.2	578.8	854.6
LBS BEEF SOLD/ACRE										
To Weaning	352.0	393.1	337.9	403.5	329.6	354.8	515.7	499.4	635.2	717.7
To Feedlot	411.8	427.2	424.3	442.8						
To Slaughter	413.0	426.0	425.3	440.6	391.6	410.6	524.8	538.7	581.0	598.4
To Slaughter	450.4	476.4	468.3	490.5	540.9	651.9	842.7	968.9	1006.1	1215.7
CALF GAINS (LBS/DAY)										
Weaning Phase	1.1	2.1	1.1	2.1	1.1	2.1	1.1	2.1	1.1	2.1
Stocker Phase, I	1.3	1.8	1.5	1.8						
Stocker Phase II	1.2	1.5	1.1	1.4						
Feedlot Phase	2.2	2.5	2.2	2.5	2.3	2.6	2.3	2.6	2.3	2.6

is designed primarily to provide an overall comparison of forage and feeding systems.

Acreage Requirements

A point often overlooked in discussions of beef production efficiency is that larger cows require more land. The increase in acreage requirements with cow size (table 22, Appendix A) was most dramatic in cow-calf operations. At weaning, table 22 showed a 6% - 7% increase in acreage requirements for each 10% increase in cow size.

Milk yield also had an effect on acreage requirements. Increasing milk yield caused a moderate increase in acreage requirements.

The primary analysis shown in table 22 assumed that fertility levels varied with cow size and milk yield (table 9). To eliminate fertility as a variable, model runs were made assuming a constant pregnancy rate of 92% for all cow sizes and milk levels. This technique aids in interpreting the results. The above conclusions about cow size and milk yield were also valid when fertility levels were held constant (table 23, Appendix A).

The most dramatic change in acreage requirements occurred between systems, especially for cow-calf operations. Though acreage requirements differed very little for Systems I - III, there was a significant reduction in acreage requirements for Systems IV and V. These last two systems included the production of large amounts of corn silage to feed cattle. Since silage produces high levels of TDN per acre, this reduction in acreage requirements was to be expected.

In determining acreage requirements at slaughter, it was assumed that all feed, including grain, was grown by the herd owner. The purchase of grain would, of course, reduce acreage requirements as illustrated in table 10.

Pounds beef sold per acre

Cow size had no discernible effect on pounds of beef sold per acre except for a slight increase at weaning time (table 24, Appendix A). This increase at weaning was not noticeable when weaning rates were held constant (table 25, Appendix A). The analysis in table 24 assumed that the larger, less fertile cows were culled and sold when they failed to re-breed. The increase in pounds of beef sold per acre at weaning was due to the sale of a higher proportion of the larger cows.

Increasing milk yield tended to increase beef produced per acre at weaning time. By slaughter, however, the inverse relationship was true. Since calves from all milk levels at a given cow size were assumed to gain at the same rate after weaning, the lighter calves from the dams with lower milk levels had less body weight to maintain than their heavier counterparts from the good milking dams. Thus the gains of the lighter calves from weaning to slaughter were more efficient.

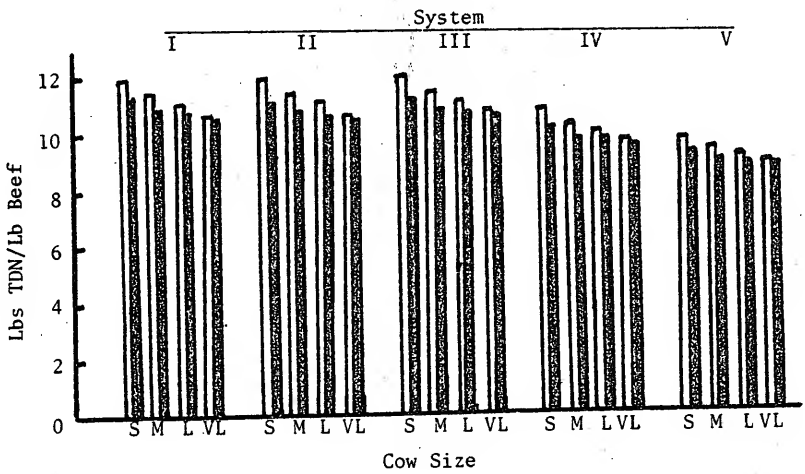
Systems IV and especially System V produced most beef per acre because the predominant source of feed was corn silage. Of the pasture systems, System II was slightly more productive than Systems I and III.

Pounds TDN per pound beef sold

At weaning larger cow sizes resulted in a slight decrease in TDN consumed per pound of beef produced (figure 6). At the end of the stocker phase and at slaughter, however, those differences between large and small cows disappeared.

Since nutrients are lost by cycling them through the cow to the calf in the form of milk, many believe that more TDN is required per unit of beef sold from heavy milking cows. Figure 6 showed exactly

AT WEANING



AT SLAUGHTER

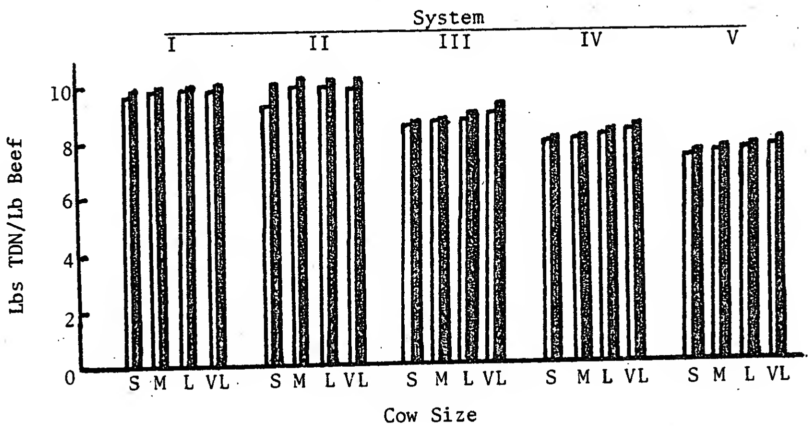


Figure 6. Pounds TDN per pound of beef sold for four cow sizes and two milk levels. (Cow size: S=850 lbs, M=950 lbs, L=1050 lbs, VL=1200 lbs; Milk yield: open line=low, solid line=high; Source: table 26, Appendix A.)

the opposite to be true. (The same phenomenon occurred at uniform weaning rates also.) There is an energy cost for maintaining a cow before parturition. In this study the heavier milking cows produced more pounds of calf at weaning to help pay for this pre-parturition energy cost. However, there was more postweaning weight to maintain at the same post-weaning gain levels. Thus the advantage for the heavier milking cows disappeared by slaughter since post-weaning gains of their calves were less efficient.

TDN per pound of beef sold decreased in Systems IV and V. These two were more intensive than the more conventional pasture systems (I-III). The average feed quality index (table 21, Appendix A) was higher and the activity factor was lower, reducing the TDN requirements for the two systems. In table 10, the pounds of TDN per animal and TDN consumed by the herd were reduced in Systems IV and V for the same reasons.

While System V was consistently the most efficient system biologically, its TDN sources (primarily corn silage) were very expensive compared to the conventional pasture systems. It was a uniformily unprofitable method of beef production. Consequently, System V was not included in the report of the economic analysis to follow.

Since cost and price levels are highly variable with time, all economic components were indexed. The highest value of a given component was assigned a value of 1.000. Thus, each component was indexed against its highest value. This indexing technique makes the data easier to interpret and should extend the time over which this study will maintain its validity.

<u>Cost Components</u>

The range of values for several cost components is shown in table 11.

Cow maintenance costs and heifer maintenance costs were those determined by Model I, and used as input data for Model II. Gain costs were also derived from Model I data. Cost per pound of TDN and cost per pound of beef sold were computed by Model II.

Cost per pound TDN consumed

Cow size and milk level seemed to have little or no effect on cost per pound of TDN consumed (table 27, Appendix A). The forage and feeding system, however, had a sizable effect on cost per pound of TDN.

System II was the cheapest throughout. Inexpensive gains were achieved by grazing stockers and replacement heifers on topseeded Coastcross bermuda pasture which provided a very economical but high quality source of TDN. For example, there was a 20% to 30% advantage for System II stockers over System I stockers which grazed more expensive summer and winter annuals on prepared seedbeds.

As expected, System IV had the highest unit TDN cost. Much of the TDN for the cow-calf operation was supplied by expensive corn silage.

Cost per pound of beef sold

Cow size had little effect on cost per pound of beef sold except at weaning. Here there was a small tendency toward increased costs for small cows, primarily at lower milk levels (figure 7). Higher milk levels tended to decrease costs per pound of beef produced, especially in light cows. At uniform weaning rates (table 29) the decrease was also apparent in larger cows.

Cost per unit of beef produced was lowest in System II. System I produced the next cheapest beef. System IV had the highest cost per pound of beef produced.

Costs per pound of beef produced were affected very little by weaning rate (tables 28 and 20, Appendix). This is not surprising since,

TABLE 11. VALUE RANGES FOR FOUR SYSTEMS, COST COMPONENTS.

	SYSTEM							
	I		II		III		IV	
	Low	High	Low	High	Low	High	Low	High
COW MAINTENANCE COSTS ($/YR/COW)	83.51	118.79	83.51	118.79	83.41	118.79	90.29	148.00
HEIFER MAINTENANCE ($/YR/REPLACEMENT)	116.44	166.26	79.31	113.65	132.52	167.80	139.30	197.01
GAIN COSTS ($/LB)								
Stocker Phase	.2401	.2929	.1671	.2016				
Feedlot Phase	.4314	.5338	.4202	.5270	.3395	.4360	.3395	.4360
COST/LB TDN ($)								
To Weaning	.0204	.0215	.0188	.0196	.0206	.0217	.0256	.0291
To Feedlot	.0234	.0243	.0192	.0199				
To Slaughter	.0262	.0278	.0220	.0236	.0311	.0349	.0379	.0391
COST/LB BEEF SOLD ($)								
At Weaning	.2217	.2549	.2004	.2352	.2227	.2635	.2555	.2828
At Feedlot	.2412	.2495	.1980	.2068				
At Slaughter	.2634	.2832	.2236	.2358	.2887	.3017	.3105	.3247

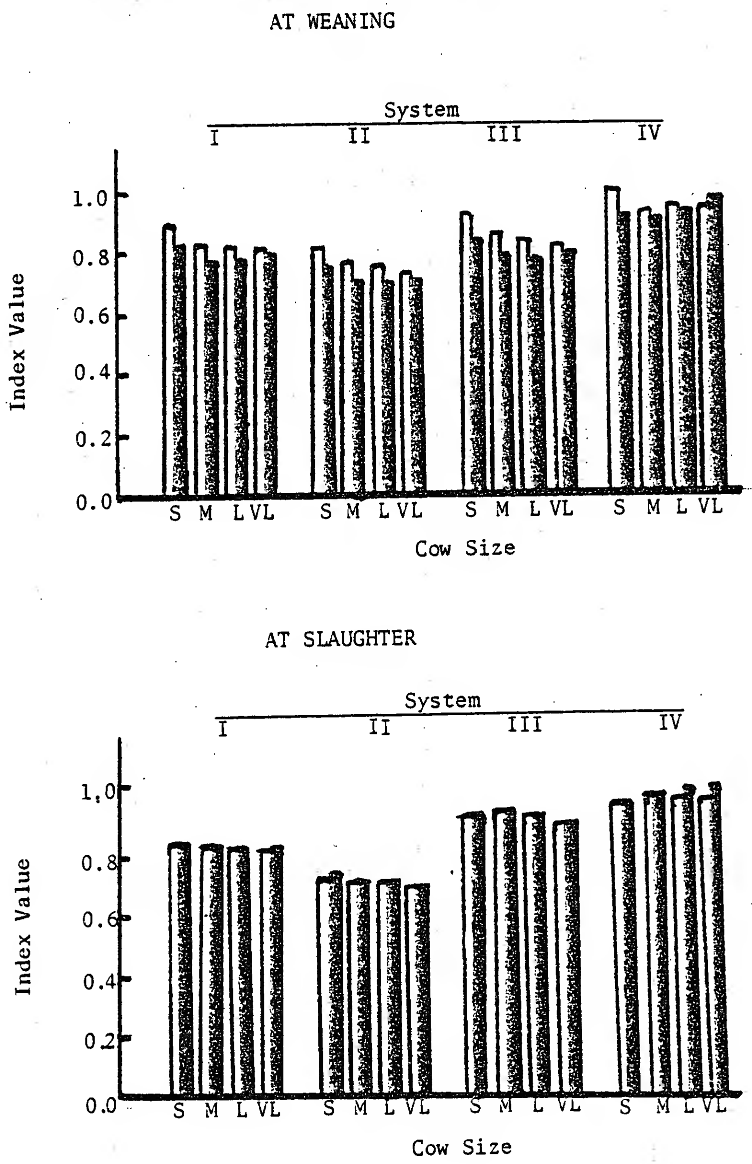


Figure 7. Indexed cost per pound of beef sold for four cow sizes and two milk levels. (Cow size: S=850 lbs, M=950 lbs, L=1050 lbs, VL=1200 lbs; Milk yield: open line=low, solid line=high; Source: table 28, Appendix A.)

in the herd management policies used in this study, non-pregnant cows were sold as soon as they weaned their last calf. This policy produced additional pounds of beef to substitute for the fewer pounds of calf beef resulting from low fertility levels.

Profit Components

The beef producer usually will evaluate the success of his operation by its profitability. There are several ways to assess profitability. The three components of profitability reported here include net returns per 1000-cow herd, net returns per pound of beef sold, and net returns per acre.

The ranges of values for each of these components are shown in table 12. The three different price structures (table 5) are included.

Returns per 1000-cow herd

Returns per 1000-cow herd are indexed in tables 30-32 (Appendix A). In cow-calf operations (i.e., at weaning) this component tended to increase as cow size increased, especially at low prices (table 31). An exception was System IV where returns appeared to parallel fertility levels. The high costs of cow maintenance and especially replacement heifers maintenance offset the additional income due to size. By slaughter time, however, there was no advantage for larger cows. Returns tended to parallel fertility levels.

Increasing milk yield increased net returns per 1000-cow herd at weaning, especially in small cows and at low prices. At slaughter these returns also tended to increase with higher milk yields in small cattle. In large cattle, however, the returns declined slightly at slaughter due to a decrease in fertility levels.

At both weaning and slaughter, System II with its low production costs produced the highest net returns for a 1000-cow herd. System I

TABLE 12. VALUE RANGES FOR FOUR SYSTEMS, PROFIT COMPONENTS.

	SYSTEM							
	I		II		III		IV	
	Low	High	Low	High	Low	High	Low	High
(HIGH-HIGH PRICE STRUCTURE)								
NET RETURNS/1000 COW HERD								
At Weaning	64660	110530	71930	124100	61510	110040	54420	93470
At Feedlot	139820	174460	161830	204830				
At Slaughter	145970	174700	168980	204960	114930	140200	91540	123620
NET RETURNS/LB BEEF SOLD								
At Weaning	.1759	.2190	.1956	.2376	.1673	.2180	.1256	.1852
At Feedlot	.1838	.2182	.2277	.2603				
At Slaughter	.1678	.1976	.2087	.2352	.1420	.1662	.1065	.1533
NET RETURNS/ACRE								
At Weaning	58.39	81.17	66.12	89.69	55.14	80.20	75.27	106.15
At Feedlot	76.68	91.65	98.69	112.50				
At Slaughter	74.32	89.95	94.63	108.94	72.15	88.95	78.64	109.66
(LOW-HIGH PRICE STRUCTURE)								
NET RETURNS/1000 COW HERD								
At Weaning	25416	60343	32680	76650	22260	59870	15180	34320
At Feedlot	109270	136670	132480	168180				
At Slaughter	145970	174700	168980	205960	114930	140200	91540	123620
NET RETURNS/LB BEEF SOLD								
At Weaning	.0691	.1018	.0889	.1253	.0606	.1008	.0413	.0680
At Feedlot	.1486	.1707	.1927	.2134				
At Slaughter	.1678	.1976	.2087	.2352	.1420	.1662	.1065	.1533
NET RETURNS/ACRE								
At Weaning	22.95	38.93	30.04	50.57	19.96	37.66	21.29	38.98
At Feedlot	61.99	71.70	50.57	92.12				
At Slaughter	74.32	89.95	94.63	108.94	72.15	88.95	78.64	109.66
(HIGH-LOW PRICE STRUCTURE)								
NET RETURNS/1000 COW HERD								
At Weaning	64660	110530	71930	124100	61510	110040	54420	93470
At Feedlot	88900	111480	112920	145030				
At Slaughter	80100	95520	105320	129950	55990	67400	35240	51710
NET RETURNS/LB BEEF SOLD								
At Weaning	.1759	.2190	.1956	.2376	.1673	.2180	.1256	.1852
At Feedlot	.1251	.1390	.1694	.1821				
At Slaughter	.0999	.1080	.1412	.1456	.0765	.0791	.0667	.0410
NET RETURNS/ACRE								
At Weaning	58.39	81.17	66.12	89.69	55.14	80.20	75.27	106.15
At Feedlot	52.19	58.41	73.44	78.55				
At Slaughter	46.17	52.09	65.64	70.22	46.52	52.95	44.05	63.14

had the second highest returns followed by System III and then System IV.

Net returns per pound of beef sold

Net returns per pound of beef sold are indexed in tables 33-35 (Appendix A). Any effect of cow size on these returns seemed to be associated with the lower fertility of larger cows except when weanling calf prices were low (table 34). Large cows showed an advantage here only because cull cow prices were assumed to remain at 33¢ per pound while calf prices dropped from 50¢ to 39¢ per pound (table 5).

At weaning, higher milk yields resulted in increased returns per pound of beef sold in Systems I through III. This was especially true in smaller cows and at low cow prices. In System IV increased milk yield was an advantage for small cows but a disadvantage for larger cows due to the substantial drop in fertility suffered by the larger cows.

At slaughter, net returns per pound of beef sold declined as milk yield increased. This decline appeared to be associated with a corresponding decline in fertility.

System II showed the highest returns per pound of beef produced at weaning and at slaughter. It was followed in rank by System I, System III, and System IV. These systems ranked the same as they did in net returns per 1000-cow herd and cost per pound of beef sold.

The spread between systems widened as the cattle got bigger and less fertile. Remember that the cost per pound of beef produced (figure 7). was about the same for both large and small cattle. Thus a herd which produced many higher-priced calves and few cheaper cull cows would be more profitable per unit of beef produced. The difference between systems

was also more pronounced at low prices.

Net returns per acre

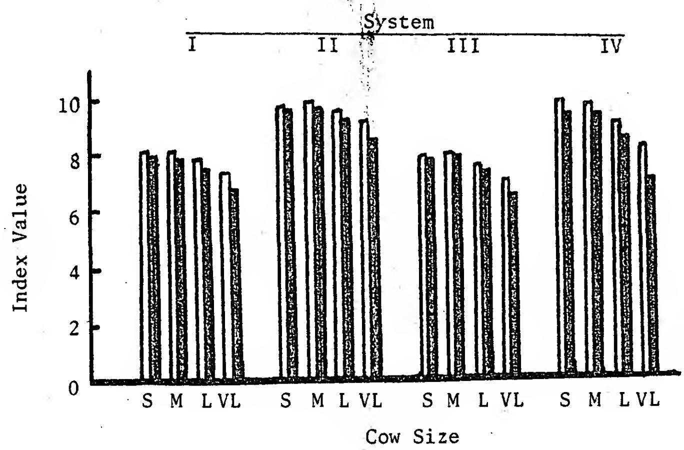
Land is a major constraint for most beef producers. They have a limited amount of land which can be devoted to beef production. Furthermore, land values have increased substantially in recent years. Consequently, one of the most important measures of profitability for most beef producers is net returns per acre. In assessing net returns per acre, this study assumed that all feed, except minerals and protein supplement, was produced on the ranch. Net returns per acre is shown in figure 8 and indexed in tables 36 through 39 (Appendix A).

Examination of data for Systems I through III in figures 8 and 9 suggests that most differences between cow size and returns per acre were due to fertility. In general there may have been a slight advantage for the 950-pound cow. The small 850-pound cow also appeared to be at a disadvantage at weaning. With low prices (table 38) there was an advantage for larger cattle at weaning only, especially in System II where heifer development costs were low. This advantage for larger cattle at low prices occurred primarily because cull cow prices were held at 33¢ while substantially lowering calf prices from 50¢ to 39¢ per pound.

In System IV where TDN costs were higher (table 27, Appendix A) there was a disadvantage for larger cattle, even at low prices. Note in figure 7 that System IV was the only system in which increasing cow size beyond 950 pounds tended to increase cost per unit of beef produced.

At weaning, there was an advantage for increased milk yield at any price structure. The advantage was more pronounced at uniform weaning rates (figure 9). Thus in the assumptions used in this study,

AT WEANING



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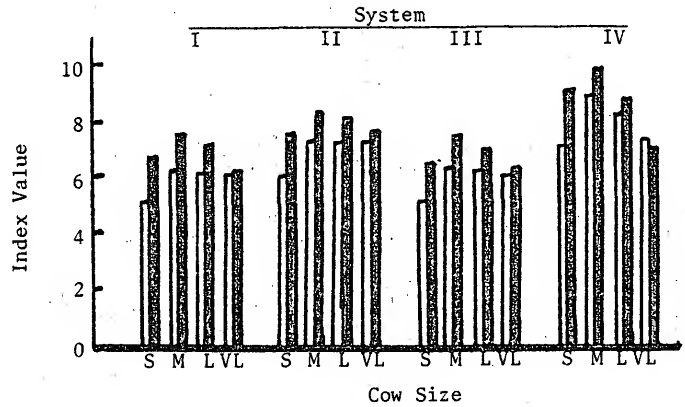
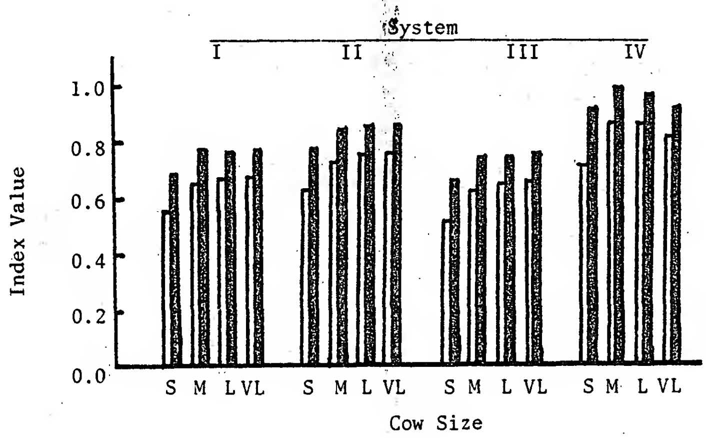


Figure 8. Indexed net returns per acre at high-high price structure for four cow sizes and two milk levels. (Cow size: S=850 lbs, M=950 lbs, L=1050 lbs, VL=1200 lbs; Milk yield: open line=low, solid line=high; Source: Table 36, Appendix A.)

AT WEANING



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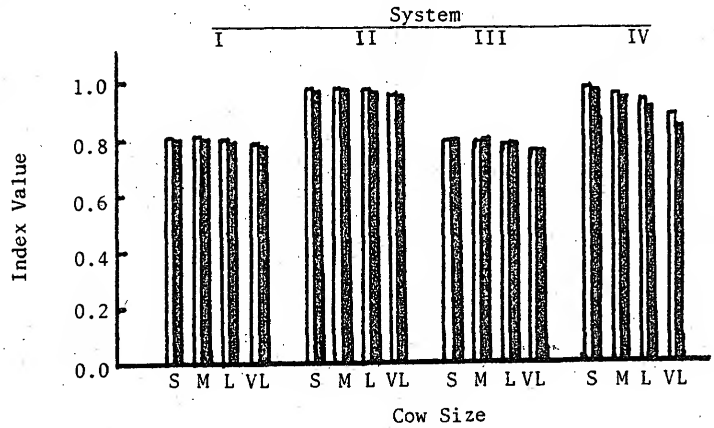

Figure 9. Indexed net returns per acre at high-high price and uniform weaning rate for four cow sizes and two milk levels. (Cow size: S=850 lbs/ M=950 lbs, L=1050 lbs, VL=1200 lbs; Milk yield: open line=low, solid line=high; Source: table 37 Appendix A.)

increasing milk yield even offset the effects of lowered fertility due to higher milk yields.

At slaughter, however, the advantages of higher milk yield disappeared. In fact, the slight differences tended to favor the lighter milking cattle, especially in System IV. Most of the declines due to increased milk yield resulted from the reduced fertility assumed to be associated with a higher milk yield.

At weaning, with a uniform weaning rate (figure 9) System IV had the highest net returns per acre. The advantage over other feeding systems was greatest with heavy milking small cows and least with large cows. When fertility levels were variable (figure 8) the larger, less fertile cows in System IV lost their advantage to comparable cows in System II.

At weaning, System II had an advantage over Systems I and III. There was very little difference between Systems I and III.

With low prices at weaning, System IV maintained a slight advantage over Systems I and III for 850- and 950-pound cows only. It lost its advantages elsewhere. System II, with its low cost per pound of beef sold (figure 7) always showed the highest net returns per acre at low price (tables 38 and 39, Appendix A).

At the end of the stocker phase (<u>i.e.</u>, at entrance to the feedlot) System II had an 18% to 20% advantage over System I at all fertility levels. This advantage was increased at low price levels-

At slaughter, Systems IV and II were very similar for 850 - and 950-pound cows at high price levels (figure 8). However, with larger cows and especially with lower prices (table 39, Appendix A), System II had the highest returns per acre. System II was always better than System I and III by 20% to 30% -- mostly due to cheap stocker gain. Systems I

and III were similar for all cows at low prices and for 850-and 950-cows at high prices. System I had a slight advantage for 1050-and 1200-pound cows at high prices.

In general, the systems ranked IV, II, I, III for net returns per acre. System IV tended to lose its advantage to System II, especially at slaughter, as cow size increased. This change in rank occurred primarily because of the higher cost of maintaining a larger cow with a lower fertility level on the expensive TDN of System IV.

Fertility, culling policy, and other factors

The effects of fertility and culling policy on production efficiency and profitability were examined by holding cow size and milk level constant. The assumptions of System I were applied to a 950-pound cow giving 10 pounds of milk per day during the first month of lactation. A 92% pregnancy rate was used as a standard against which to compare other fertility levels and culling policies.

Pregnancy rate

The effects of reducing the pregnancy rate to 86% and 80% are shown in table 13 (management factors B and C). Reducing pregnancy rate reduced acreage requirements per 1000-cow herd since there were fewer cows to maintain after weaning time (all open cows were culled at weaning) and also fewer weaned calves to feed. Thus, within the limited pregnancy rates studied here, beef production per acre actually increased due to the sale of a larger number of heavy cull cows.

While the biological components appeared to favor decreased pregnancy rates, the opposite was true for the economic components. Costs per pound of beef produced increased and net returns per acre decreased as pregnancy rate dropped. Reducing the pregnancy rate from 92% to 80% reduced net returns per acre by 17.5% at weaning and 13.7% at

TABLE 15. FACTORS AFFECTING PRODUCTION EFFICIENCY AND PROFITABILITY, UNIFORM COW SIZE AND MILK LEVEL.

	Item	At Weaning	At Feedlot	At Slaughter
A. Standard System, 92% Pregnancy	Acres/1000 Cows	1306.8(1.000)[a]	1873.1(1.000)	2092.4(1.000)
	Beef/Acre (lbs)	361.4(1.000)	417.8(1.000)	418.8(1.000)
	Cost/Lb ($)	.2233(1.000)	.2463(1.000)	.2714(1.000)
	Profit/Acre ($)	76.44(1.000)	84.25(1.000)	88.45(1.000)
B. Decrease Pregnancy to 86%	Acres/1000 Cows	1278.5(0.978)	1748.3(0.933)	1930.5(0.923)
	Beef/Acre (lbs)	371.2(1.027)	418.7(1.002)	419.4(1.001)
	Cost/Lb ($)	.2324(1.018)	.2469(1.002)	.2694(0.993)
	Profit/Acre ($)	69.88(0.914)	78.59(0.033)	82.90(0.937)
C. Decrease Pregnancy to 80%	Acres/1000 Cows	1250.2(0.957)	1623.8(0.867)	1768.3(0.845)
	Beef/Acre (lbs)	381.3(1.055)	419.7(1.005)	420.3(1.003)
	Cost/Lb ($)	.2363(1.034)	.2477(1.006)	.2670(0.034)
	Profit/Acre ($)	63.03(0.825)	72.06(0.885)	76.33(0.863)
D. Cull Open Cows After Calving Season Instead of at Weaning	Acres/1000 Cows	1391.4(1.065)	1957.8(1.045)	2177.1(1.040)
	Beef/Acre (lbs)	339.4(0.939)	399.8(0.957)	402.5(0.961)
	Cost/Lb ($)	.2410(1.056)	.2540(1.031)	.2782(1.025)
	Profit/Acre ($)	67.48(0.383)	77.53(0.920)	82.26(0.030)
E. Cull Open Cows After Calving Season Instead of at Weaning; 80% Pregnancy Rate	Acres/1000 Cows	1411.5(1.080)	1785.1(0.953)	1929.7(0.922)
	Beef/Acre (lbs)	337.8(0.035)	381.8(0.914)	385.1(0.920)
	Cost/Lb ($)	.2604(1.141)	.2644(1.073)	.2824(1.041)
	Profit/Acre ($)	47.74(0.625)	59.15(0.702)	64.04(0.724)
F. Cull 15% of Cow Herd Instead of all Open Cows; 80% Pregnancy Rate	Acres/1000 Cows	1487.6(1.138)	2028.3(1.083)	2237.7(1.069)
	Beef/Acre (lbs)	291.6(0.807)	359.9(0.861)	366.2(0.874)
	Cost/Lb ($)	.2735(1.198)	.2736(1.110)	.2961(1.091)
	Profit/Acre ($)	49.77(0.651)	63.77(0.757)	69.43(0.785)
G. Cull 15% of Cow Herd Instead of all Open Cows; 80% Pregnancy Rate	Acres/1000 Cows	1487.6(1.138)	1980.5(1.057)	2171.3(1.038)
	Beef/Acre (lbs)	274.3(0.759)	342.5(0.820)	349.8(0.835)
	Cost/Lb ($)	.2907(1.273)	.2839(1.153)	.3050(1.124)
	Profit/Acre ($)	41.11(0.538)	56.34(0.669)	62.31(0.704)
H. Cull 15% of Cow Herd Instead of all Open Cows; 86% Pregnancy Rate; 3% Increase in Cow Death Loss	Acres/1000 Cows	1513.2(1.159)	2028.2(1.083)	2227.6(1.065)
	Beef/Acre (lbs)	277.7(0.768)	346.3(0.829)	353.5(0.844)
	Cost/Lb ($)	.2922(1.280)	.2848(1.156)	.3060(1.127)
	Profit/Acre ($)	41.66(0.545)	57.04(0.677)	63.36(0.716)
I. Increase Slaughter Price by 25¢; Stocker Price by 1¢	Acres/1000 Cows	1306.8(1.000)	1873.1(1.000)	2097.4(1.000)
	Beef/Acre (lbs)	361.4(1.000)	417.8(1.000)	318.8(1.000)
	Cost/Lb ($)	.2283(1.000)	.2463(1.000)	.2714(1.000)
	Profit/Acre ($)	76.44(1.000)	87.54(1.039)	96.92(1.096)
J. Increase Slaughter Price by 5¢; Stocker Price by 3¢	Acres/1000 Cows	1306.8(1.000)	1873.1(1.000)	2092.4(1.000)
	Beef/Acre (lbs)	361.4(1.000)	417.3(1.000)	418.8(1.000)
	Cost/Lb ($)	.2283(1.000)	.2463(1.000)	.2714(1.000)
	Profit/Acre ($)	76.44(1.000)	94.11(1.117)	105.39(1.192)
K. Include $45,000 Overhead Expenses in Costs	Acres/1000 Cows	1306.8(1.000)	1873.1(1.000)	2092.4(1.000)
	Beef/Acre (lbs)	361.4(1.000)	417.8(1.000)	418.8(1.000)
	Cost/Lb ($)	.3236(1.417)	.3038(1.233)	.3227(1.190)
	Profit/Acre ($)	42.00(0.549)	60.23(0.715)	67.75(0.766)

[a]Values in parantheses are indexed against standard system, Factor A.

slaughter.

Culling practices

Management factors A, B, and C assumed that all non-pregnant cows were culled as soon as their last calf was weaned. This practice would entail pregnancy testing cattle at weaning time. Many producers do not perform this test but may cull non-pregnant cattle as soon as they are identified at the end of the calving season. This would result in non-pregnant cows being maintained for approximately 6 months after calving, as is assumed for management factors D and E. By comparing factors D and E to their counterparts, A and C, the effects of delayed culling can be assessed.

Delaying the culling of open cows for 6 months increased acreage requirements and reduced beef production per acre. Costs per pound of beef produced rose and net returns per acre were reduced. Where pregnancy rate was maintained at 92%, failure to remove open cows until 6 months after weaning reduced net returns per acre by 11.7% at weaning. The reduction was even more drastic at the 80% pregnancy rate.

Another common practice among beef producers is to cull a certain proportion of the cow herd regardless of fertility status and calving history. Usually no production records are kept in such herds. Thus open cows may remain in the herd for an entire year or more without weaning a calf. Management factors F, G, and H reflect such management practices. Here open cattle were assumed to remain in the herd for one year after weaning their last calf. Each year 15% of the cow herd was culled regardless of fertility status.

Comparing management factors F and G to their counterparts B and C, there was a significant increase in acreage requirements per 1000-cow herd and a reduction in beef produced per acre. At weaning, costs per

pound of beef rose by 18% to 24%. Net returns per acre were drastically reduced. Factor G with an 80% pregnancy rate was 46.2% less profitable than A, at weaning, compared with only a 17.5% reduction for C, where the pregnancy rate was also 80% but culling was practiced as soon as an open cow weaned her last calf.

The culling of only 15% of the herd annually may result in an increase in death loss as old cows are over-looked at culling time. The effect of increasing the death loss rate from 2% to 5% is shown in management factor H. The increase in acreage requirements at weaning occurred because the program allotted additional acreage for the growing of replacement heifers to replace dead cows. Note that the additional death losses resulted in a substantial reduction in net returns per acre.

The Beef Research Unit data discussed previously suggested that carcass quality may affect profitability. Since increasing carcass quality presumably has no effect on production costs, the improved carcass would obviously increase profit if this quality were rewarded by the markets. Factors H and I represent an increased animal value, such as might occur with increased carcass quality or yield grade. A 5% increase in slaughter price (factor I) resulted in a 9.6% increase in net returns per acre, while 10% increase in slaughter price yielded a 19.2% increase in net returns per acre at slaughter. Naturally, the effect of this increase in slaughter price will depend on the profit margin. The smaller the profit margin, the greater the percent increase in profit.

Table 40 lists overhead items and fixed expenses which might be common to a 1000-cow ranching operation. These items had been omitted in this study since they can vary greatly from ranch to ranch

and because it was not necessary to include them for the comparisons made here. The effects of their inclusion, however, are illustrated in management factor K. For a cow-calf operation the overhead items in table 40 would increase cost per pound of beef produced by 41.7% and reduce returns per acre by 45.1%. If they represented the overhead costs of a conception to slaughter ranching operation, cost per pound would be increased by 19.0% and net returns per acre would be reduced 23.4% by their inclusion in the analysis.

Factors Affecting Biological Efficiency

Cow size

Except for the increase in acreage requirements, there were no substantial effects on biological efficiency with changes in cow size. Beef produced per acre and TDN per unit of beef produced were affected very little by changes in cow size.

Milk yield

Increasing milk yield resulted in a moderate increase in acreage requirements and an increase in beef produced per acre at weaning, Because the calves from heavy milking cows were larger at weaning, they tended to gain less efficiently from weaning to slaughter. Consequently, by slaughter, beef produced per acre was slightly decreased and TDN per unit of beef produced was increased for herds with heavier milking dams.

An important point concerning the effects of milk yield on biological efficiency emerges from an examination of the data on TDN per unit of beef produced at weaning. Contrary to popular belief, TDN per unit of beef decreased as milk yield increased. The heavier milking cow weaned a heavier calf. Thus, for her production year, which ended at weaning, the heavy milking cow had more pounds of calf to offset

her pre-parturition TDN costs.

Fertility

In this study, all non-pregnant cows were culled at the very beginning of the production year, immediately after they had weaned their previous year's calf. A heifer calf was kept to replace each culled cow. Because of this management practice, acreage requirements were reduced and beef production per acre increased slightly as weaning rate declined (table 13). However, if open cows were allowed to remain in the herd after weaning their last calf, acreage requirements increased and beef production per acre decreased as fertility declined.

Forage and feeding systems

Table 14 summarizes the rankings of the five forage and feeding systems for efficiency. System V was consistently the most efficient system biologically. It was always followed in rank by System IV. All of the TDN for System V was produced by corn or corn silage. Much of the TDN from System IV came from the same sources. Corn produces a high yield of TDN per acre. Consequently, it is not surprising that acreage requirements were low and beef production per acre was high in these two systems.

TDN was also utilized more efficiently in these two systems as shown by the data on TDN per pound of beef produced. Corn and corn silage have high feed quality indices, meaning that they are converted to net energy more efficiently. Furthermore, animals in Systems IV and V were more confined, requiring less energy for incidental activity.

Factors Affecting Profitability

Cow size

In general, this study consistently indicated that cow size alone had little or no effect on profitability. The exception was returns

per 1000-cow herd, which is probably not a practical measure of profitability. As cow size increased returns per 1000-cow herd increased, while returns per pound of beef and returns per acre remained about constant. Any differences in the latter two can be explained by differences in fertility associated with cow size.

Milk yield

Increasing milk yield always decreased costs and increased returns at weaning. Generally the decline in fertility assumed to be associated with increased milk yield was offset so that there was a net advantage at weaning for increased milk yield. Excessive drops in fertility would, of course, negate this advantage.

The advantage for increased milk yield did not persist for the herd in which calves were maintained until they were ready for slaughter. Calves from heavy milking cows weighed more at weaning. Since they were assumed to gain at the same rate as their smaller counterparts from light milking cows of the same weight, these heavier calves did not gain as efficiently.

These results point out a well recognized discrepancy between the cow-calf producer and operator who grows out the calves. Because of increased feed efficiency and compensatory growth, the calf grower, under favorable feed price conditions, generally prefers the lighter calves. However, heavy calves are more profitable for the cow-calf producer. This study suggests that if a producer intends to maintain his calves through a stocker phase or until slaughter, he might strive for a moderate level of milk production in his brood cow herd.

Fertility

Fertility is without doubt the major factor determining the profitability of beef production. In fact, it was the only animal production

TABLE 14. SUMMARY OF FORAGE AND FEED SYSTEM RANK FOR EFFICIENCY COMPONENTS.

	System Number and Feed Type				
Life Stage	I	II	III	IV	V
Cow-calf	Pasture	Pasture	Pasture	Pasture & Drylot	Drylot
Stocker	Annual Forage	Topseeded Permanent Forage	--	--	--
Finishing	Feedlot	Feedlot	Feedlot	Feedlot	Feedlot

Rank
(Highest = 1)

Biological Components					
Acreage Requirements	1	3	2	4	5
Lb Beef/Acre	5	3	4	2	1
Lb TDN/Lb Beef	2	1	3	4	5
Cost Components					
Cost/Lb TDN	3	4	2	1	a/
Cost/Lb Beef Sold	3	4	2	1	a/
Profit Components					
Returns/1000 Cows	2	1	3	4	a/
Returns/Lb Beef Sold	2	1	3	4	a/
Returns/Acre	3	2 b/	4	1	a/

a/ System V always unprofitable; not ranked.

b/ System II ranks first at weaning if prices are low, and at slaughter if prices are low or cows are large.

character examined in this study which consistently showed a substantial effect on profitability. Increasing fertility always increased profitability.

Culling and management policies

In table 13 culling policies were shown to have a dramatic effect on profitability. It is very important to pregnancy test brood cows at weaning time, to cull them from the herd immediately, and to replace them with a heifer. This practice avoids a winter feed bill for a non-productive cow, reduces production costs, and generates income from the sale of a large animal. The practice is especially important in herds with low fertility levels. Much of the profit reducing effect of lowered fertility can be offset by culling open cows at weaning time.

Forage and feeding system

Forage and feeding systems were major factors influencing profitability. (See table 14 for a summary of feeding systems.) System II, which included a topseed permanent pasture for growing out calves, produced the cheapest beef and had the highest returns per unit of beef sold. However, System IV, in which cows were stocked at 1.67 animals per acre and supplemented with corn silage, usually produced the highest returns per acre unless cattle prices or fertility levels were low. Smaller cows with low maintenance requirements did well in System IV, particularly if calves are maintained until slaughter. System IV was more sensitive to cow size than System II, especially at slaughter.

This study suggests that Systems II and IV might be advantageous production systems for beef producers. Thus far, it appears that the use of similar systems has been limited to university experiment station

studies.

Utley, Marchant, and McCormick (1976) reported on the use of topseeded bermuda pastures for fattening calves, though his pastures contained no legumes as in System II. In studies in Georgia (Neville and McCormick, 1976) and Louisiana (Doane, 1976) cow-calf operations have been stocked at approximately 1.5 animal units per acre on heavily fertilized bermuda pasture. The Georgia study produced 487 pounds of beef per acre with 288 pounds of nitrogen but required some hay purchases. The Louisiana study, on bermuda pastures topseeded with clover and ryegrass, produced 641 pounds of beef per acre with 239 pounds of nitrogen. It also produced about 0.5 tons of surplus hay per acre.

System IV, as reported here, produced an estimated 516 to 600 pounds of beef per acre for a cow-calf operation on clover-grass pastures with no nitrogen fertilization. Corn silage was used as a supplement when pasture was inadequate. System IV would appear to achieve per acre production rates slightly lower than that of the Louisiana trial and higher than the Georgia trial, but with much lower levels of fertilization.

CHAPTER VI
RESEARCH RECOMMENDATIONS AND APPLICATION OF RESULTS

Recommendations for Additional Research

A major benefit of modeling studies is the discovery of areas where current knowledge is inadequate or non-existent. The model building process revealed several areas where information was lacking.

The net energy system is useful for expressing the energy requirements of animals in terms of animal weight and gain. The techniques which measure the energy of animal feeds, however, report these values in other forms (metabolizable energy, digestible energy, or TDN) which must then be converted to net energy for modeling purposes. The relationship between feed quality, especially forage quality, and the efficiency of metabolizable energy (or TDN) conversion to net energy is not easy to quantify accurately using currently available information.

The energy cost of incidental acitivity should be a fairly simple determination and is quite important for modeling beef operations under pasture and range conditions. Nevertheless, there is very little information on this energy cost.

The nutritional requirements of cattle during gestation is another subject which needs more clarification. Dairy scientists generally allow additional energy for gestation. Their recommendations, however, are based on confined animals. Beef cattle are usually not confined and have the option of reducing their activity to conserve energy during

gestation. Brody (1945) found that some animals use this option to reduce energy requirements during gestation. More information is needed on this subject.

In selecting the assumptions to be used in the models, an abundance of animal production data was usually available. However, data on the month-to-month production of pastures was almost non-existent. The accuracy of beef production modeling studies could be greatly enhanced if data were available on the harvestable nutrients available monthly from various types of pasture programs. It would also be advantageous to have animal response data from pastures reported monthly. In fact, monthly harvestable pasture nutrients could be estimated from animal response data collected at monthly intervals.

The results of the Coastal Plains study reported here also suggest the need for some additional work. System II in which top-seeded bermuda pastures were used for fattening calves showed exceptional promise as a low-cost method of beef production. Though one such study has been reported (Utley, Marchant, and McCormick, 1976), additional comparisons are needed between this system and the traditional system of growing calves on annual pastures in the southeastern United States.

The pasture-drylot system of cow-calf production, simulated as System IV, also needs immediate evaluation by researchers. Here is a system which appears to be economically feasible. It may be an appropriate system for the beef producer with serious land constraints.

Application of Results

This study suggested several production practices which should

improve net returns for beef producers. The importance of maintaining high fertility levels was consistently demonstrated by the study. Commonly recommended practices such as regular culling of non-pregnant cows, proper nutrition during the breeding season, and prevention of reproductive diseases should result in higher fertility levels and pay handsome dividends to the producer. No other animal production trait approaches fertility in economic importance.

The results of the analysis of forage and feeding systems may have some valuable applications for producers. A program such as System II where calves are grown out on topseeded perennial grass pastures has the potential for producing an excellent quality forage at a low cost. If a producer has limited land resources he might benefit from a semi-intensive program such as System IV with pastures stocked at high rates and supplemented with silage.

This study clearly demonstrated the value of culling non-pregnant cows as soon as that cow weans its last calf. By pregnancy testing and culling cows at weaning time, the producer avoids the expense of wintering a non-productive cow.

The study also suggests that producers, generally, need not worry about selecting for an optimum cow size. In most production systems, cow size has little or no effect on profitability if fertility levels are kept high. In an intensive production system, however, where more expensive high-energy feeds are used (e.g., System IV), large cows may be at a disadvantage.

Results from the Beef Research Unit analysis indicated that yield grade and carcass quality grade can influence profitability. Since improved carcass merit will increase animal value but is not likely to add to production costs, selection for that trait is a desirable

production goal.

The study demonstrated that heavy milking cows were more profitable at weaning that light milking cows, provided fertility levels were maintained. Thus, a cow-calf producer who sells only weanling calves should select reasonably fertile cattle with strong milking ability. When calves were maintained in the same herd through a stocker phase or until slaughter, the advantage for the heavier milking cow was lost. Consequently the producer who maintains his calves from birth to slaughter should select principally for fertility and carcass merit, letting milk production seek a compatible level.

CHAPTER VII
SUMMARY AND CONCLUSIONS

Two mathematical models for the evaluation of beef production systems have been developed and described. The models were computerized using DYNAMO programming. The models are easy to use, inexpensive to run, and can be used to evaluate any beef production system where standard input data is available. The first model, a cow efficiency estimator, computed the TDN requirements for a cow and her calf using variables such as animal weight and gains, seasonal changes in cow weight, cow milk production, physical activity of the animals, and the quality of feed being consumed. Costs for TDN from various sources were determined.

The second model, a herd efficiency estimator, used data from the first model plus data on cattle prices, fixed costs, pregnancy and calf survival rate, death losses, heifer replacement and culling policies, herd size, and TDN produced per acre from each TDN source. This model calculated biological efficiency factors such as TDN per animal or per herd, acreage requirements per herd, and beef produced per acre. It also computed economic efficiency factors such as cost per pound of gain, cost per pound of TDN, cost per pound of beef sold, net returns to the herd, net returns per pound of beef sold, and net returns per acre.

The models were used to examine the effects of cow size, fertility, milk yield, and calf gain on production efficiency and profitability.

They were also used to evaluate three different market structures, different herd culling policies, and five feeding and pasture systems suitable to the southeastern United States. Interactions between animal production characteristics, market structures, and feeding systems also emerged.

The models were used first to analyze data from five breed groups which were collected at the University of Florida Beef Research Unit from 1964 to 1972. The Beef Research Unit analysis provided a means of testing the performance of the two models described above on a set of well documented animal performance data. In the view of experienced investigators associated with the Beef Research Unit project, the model performed credibly and yielded new and valuable insights into the comparitive biological and economic efficiencies of the five breed groups of cattle at the research unit. These breed groups were comprised of Angus, Hereford, Hereford-Angus, Angus-Brahman, and Hereford-Santa Gertrudis.

Measures of biological efficiency included pounds of TDN per pound of beef sold and pounds of beef sold per acre. Although there were wide variations in cow sizes and milk yield, these traits indicated few differences in biological efficiency. In no case did the difference between any two breed groups exceed 3.5%.

When economic efficiency was examined the breed groups showed only minor differences in cost per pound of beef sold. However, there were some differences in the profit components which included net returns per acre and net returns per pound of beef sold. The highly fertile Angus-Hereford cross ranked first in all measures of profitability. In general, the straightbred Angus ranked second, the Angus-Brahman cross third, the straightbred Hereford fourth, and

the Hereford-Santa Gertrudis cross last. The breed groups ranked almost exactly as they ranked in weaning percent. There appeared to be no relationship between these rankings and cow sizes.

A major objective of the study was to compare alternative systems of beef production for the southeastern United States. Several animal production traits were examined within five forage and feeding systems. Among these animal production traits were cow size, milk yield, and fertility level.

Cow size had no effect on measures of biological efficiency. In general, this study also consistently indicated that cow size alone had little or no effect on profitability. Most differences in profitability between cow size could be explained by the differences in fertility assumed for different cow sizes. Eliminating fertility as a variable removed most of these differences.

Increasing milk yield improved biological efficiency, decreased costs and improved returns at weaning. However, if the calf was maintainedin the herd and finished to slaughter weight, there was no advantage for high milk yield in the cow herd.

Fertility was the only animal production characteristic examined in the study which consistently showed a substantial effect on profitability. Increasing fertility always increased profitability.

The effects on profitability of fertility levels and fertility management policies were examined in more detail by holding cow size, cow milk yield, calf gain, and feeding system constant. Three fertility levels and three different culling methods were studies. In the standard system cows had a 92% pregnancy rate and were culled for non-pregnancy as soon as they weaned their last calf. When calves were sold at weaning, net returns per acre were reduced by 17.5% when the

pregnancy rate dropped from 92% to 80%. When culling of non-pregnant cows was delayed until six months after weaning, then net returns per acre for the 80% pregnancy rate were 37.5% less than the standard system. In a third culling method 15% of the cow herd was culled at the end of the production year regardless of pregnancy status. Using this culling method and an 80% pregnancy rate, net returns per acre at weaning were 46.2% less than for the standard system. When calves were held until slaughter, the effects of lowered pregnancy rate or inadequate culling procedures was the same, though the reductions in net returns per acre were not as dramatic as at weaning.

This phase of the study emphasized the importance of maintaining high levels of fertility. However, even in herds with mediocre fertility levels, profits can be significantly improved by pregnancy testing and culling all non-pregnant cows at weaning time.

Factors such as the forage and feeding system also had a substantial effect on biological efficiency and profitability. Five hypothetical forage and feeding systems suitable to the southeastern United States were examined. System V in which cows were fed corn silage in confinement, produced the most beef per acre and had the lowest TDN per pound of beef produced, but this system was uniformly unprofitable because of the high cost of feeding corn silage in a drylot. System IV where cows were heavily stocked at 1.67 animal units per acre on pasture and supplemented with corn silage, rated second in the two measures of biological efficiency and with high cattle prices also gave the greatest returns per acre. System II, an all perennial grass system with stocker calves grown on topseeded Coastcross bermuda, had the lowest cost per pound of beef and the highest return per pound of beef sold. It also surpassed System IV in net returns per acre

when cattle prices were low.

The study indicated several interactions between animal production traits, forage and feeding systems, and market prices. Large cows were at a disadvantage where feed costs were high such as in System IV where a high proportion of the diet was composed of corn silage fed on heavily stocked pasture. System IV generally gave the highest net returns per acre but lost its advantage if pregnancy rate dropped or if market prices were lowered. Cows with heavy milk levels were more profitable if calves were sold at weaning but had no advantage for a producer who maintained calves through a stocker or feedlot phase.

These interactions demonstrate the futility of searching for a universally optimum beef production system. To determine an optimum system it is necessary to know such factors as the production potential of the animals, environmental conditions, alternative nutritional programs and market potential. Once these factors are known for a given area and time, tools such as the models developed in this research can be very useful in building recommendations for a beef production system.

TABLE 15. PASTURE BUDGET: CLOVER-GRASS.

Item	Unit	$/Unit	Quantity/Acre	Amount/Acre
Fertilizer				
0-10-20	cwt.	4.75	5.00	23.75
Lime[a]	ton	15.00	0.33	5.00
Chemicals				
Insecticide	lb.	0.70	1	1.70
Herbicide	appl.	3.00	1	3.00
Tractor and Equipment				
Fall Discing	hr.	8.50	0.25	2.13
Spraying (twice)	hr.	5.00	0.24	1.20
Total				$36.78

[a]One ton/acre, every three years.

TABLE 16. PASTURE BUDGET: RYEGRASS-CLOVER-COASTCROSS BERMUDA.

Item	Unit	$/Unit	Quantity/Acre	Amount/Acre
Seed				
Ryegrass	lb.	0.30	20	6.00
Fertilizer				
0-10-20	cwt.	4.75	5.0	23.75
Nitrogen	lb.	0.28	50	14.00
Lime[a]	ton	15.00	0.33	5.00
Chemicals				
Insecticide	lb.	1.70	1	1.70
Herbicide	appl.	3.00	1	3.00
Tractor and Equipment				
Fall Discing	hr.	8.50	0.25	2.13
Seeding	hr.	4.00	0.12	0.48
Rolling	hr.	4.50	0.12	0.54
Spraying (twice)	hr.	5.00	0.25	1.20
Total				$57.80

[a]One ton/acre, every three years.

TABLE 17. PASTURE BUDGET: RYE-RYEGRASS-CRIMSON CLOVER.

Item	Unit	$/Unit	Quantity/Acre	Amount/Acre
Seed				
Rye	bu.	6.50	1.25	8.13
Ryegrass	lb.	0.30	15	4.50
Crimson Clover	lb.	1.20	8	9.60
Fertilizer				
4-16-16	cwt.	6.25	5.0	31.25
Nitrogen (applied)	lb.	0.28	40	11.20
Lime[a]	ton	15.00	.167	2.50
Tractor and Equipment				
Discing (twice)	hr.	8.50	0.5	4.25
Planting	hr.	6.50	0.4	2.60
Labor	hr.	2.50	1.1	2.75
Total				$76.78

[a]One ton/acre, every three years; two crops/year.

TABLE 18. PASTURE BUDGET: MILLET.

Item	Unit	$/Unit	Quantity/Acre	Amount/Acre
Seed				
Millet	lb.	0.30	25	7.50
Fertilizer				
4-16-16	cwt.	6.25	5.0	31.25
Nitrogen (Applied)	lb.	0.28	80	22.40
Lime[a]	ton	15.00	.167	2.50
Tractor and Equipment				
Discing (twice)	hr.	8.50	0.5	4.25
Planting	hr.	6.50	0.4	2.60
Labor	hr.	2.50	1.1	2.75
Total				$73.25

[a]One ton /acre, every three years; two crops/year.

TABLE 19. RATION COMPOSITION AND COSTS.

A. Feedlot Ration and Heifer Supplement

Ingredient	Lbs.	% TDN	TDN (lbs.)	Cost ($)	Total Cost
Ground Ear Corn	1900	72.6%	1379.4	3.00/bu.	$81.42
60% Protein Supplement	100	45%	45.0	10.60/cwt.	10.60
Grinding and Mixing				6.00/ton	6.00
Total	2000		1424.4		$98.02

TDN Cost = $.069/Lb. TDN

B. Silage Wintering Ration

Ingredient	Lbs.	% TDN	TDN (lbs.)	Cost ($)	Total Cost
Corn Silage[a]	1950	25%	487.5	17/ton	$16.57
41% CSM	50	112%	56.0	6.75/cwt.	4.90
Total	2000		543.9		$21.47

TDN Cost = $.039/Lb. TDN

C. Corn Silage Production

Item	$/ton
Field Production Cost[b]	10.00
Cutting and Hauling	3.50
Storage and Feeding[c]	3.50
Total	$17.00/ton

[a]See C

[b]Average Yield = 12 tons/acre silage or 60 bushels/acre ear corn

[c]Includes 12% storage loss in bunker silo

TABLE 20. BREEDING COSTS.

		$/year	$/cow[a]
Average Bull Cost	1000.00		
Bull Salvage Value	350.00		
Total Depreciation	650.00		
Annual Depreciation (4 yrs./bull)		162.50	6.50
Bull Feed and Maintenance[b]		40.00	1.60
Bull Pasture Costs		55.17	2.21
Total Breeding Costs		257.67	10.31

[a]Assumes one bull per 25 cows

[b]1½ acres pasture per bull @ $36.78 per acre (See table 15.)

TABLE 21. ASSUMPTIONS USED IN ANALYSIS OF COASTAL PLAINS SYSTEMS.

	SYSTEM	MONTH	Jan Jul	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec
Cow Weight Factor	I-V	Jan-Jun	1.10	1.00	0.95	0.96	0.97	0.98
		Jul-Dec	0.99	1.00	1.02	1.04	1.07	1.09
Cow Feed Quality Index	I-III	Jan-Jun	5	5	7	7	7	5
		Jul-Dec	5	4	3.5	3.5	3	5
	IV	Jan-Jun	5	5	7	7	7	5
		Jul-Dec	5	4	5	5	5	5
	V	Jan-Jun	5	5	5	5	5	5
		Jul-Dec	5	5	5	5	5	5
Cow-Calf Pasture TDN Cost ($/Lb)	I-III	Jan-Jun	0.010	0.010	0.010	0.010	0.010	0.010
		Jul-Dec	0.010	0.010	0.010	0.010	0.010	0.010
	IV	Jan-Jun	0.007	0.007	0.007	0.007	0.007	0.007
		Jul-Dec	0.007	0.007	0.007	0.007	0.007	0.007
	V		No Pasture					
Cow-Calf Supplement TDN Cost ($/Lb)	I-V	Jan-Jun	0.039	0.039	0.039	0.039	0.039	0.039
		Jul-Dec	0.039	0.039	0.039	0.039	0.039	0.039
Available AUM's Grazing	I-III	Jan-Jun	0.1	0.1	0.7	1.1	1.2	1.2
		Jul-Dec	1.2	1.0	0.9	0.6	0.4	0.2
	IV	Jan-Jun	0.0	0.0	0.9	1.0	1.1	1.3
		Jul-Dec	2.0	1.7	1.0	0.3	0.0	0.0
	V	Jan-Jun	0	0	0	0	0	0
		Jul-Dec	0	0	0	0	0	0
Pasture Stocking Rate (Acres/AU)	I-III	Jan-Jun	1.3	1.3	1.3	1.3	1.3	1.3
		Jul-Dec	1.3	1.3	1.3	1.3	1.3	1.3
	IV	Jan-Jun	0.6	0.6	0.6	0.6	0.6	0.6
		Jul-Dec	0.6	0.6	0.6	0.6	0.6	0.6
	V		No Pasture					
Stocker Feed Quality Index	I	Jan-Jun	7	7	7	7	7	6
		Jul-Dec	6	6	5	5	5	7
	II	Jan-Jun	5	7	7	7	7	6
		Jul-Dec	6	6	5	5	5	5
	III-V		No Stocker Grazing					
Cost of Stocker TDN ($/Lb)	I	Jan-Jun	.0313	.0313	.0313	.0313	.0313	.0205
		Jul-Dec	.0205	.0205	.0205	.0390	.0390	.0313
	II	Jan-Jun	.0390	.0105	.0105	.0105	.0105	.0105
		Jul-Dec	.0105	.0105	.0105	.0390	.0390	.0390
	III-V		No Stocker Grazing					
Stocker Supplement Factor	I	Jan-Jun	0	0	0	0	0	0
		Jul-Dec	0	0	0	1	1	0
	II	Jan-Jun	1	0	0	0	0	0
		Jul-Dec	0	0	0	1	1	1
	III-V		Not Stocker Grazing					
Cost of Feedlot TDN ($/Lb)	I-V	Jan-Jun	0.069	0.069	0.069	0.069	0.069	
		Jul-Dec	0.069	0.069	0.069	0.069	0.069	

TABLE 22. ACREAGE REQUIREMENTS, 1000 BROOD COW HERD.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM				
		I	II	III	IV	V
				TO WEANING		
850	7	1107.4	1087.9	1115.5	712.9	578.8
	9	1158.4	1136.4	1166.5	747.3	609.3
	11	1210.9	1187.3	1219.5	782.6	641.1
	13	1264.6	1238.9	1274.4	818.3	674.2
950	8	1253.2	1232.9	1261.7	810.2	661.0
	10	1306.8	1284.5	1316.0	844.3	693.6
	12	1361.7	1337.3	1372.1	880.5	727.6
1050	9	1337.7	1308.4	1347.6	864.0	709.4
	11	1387.5	1359.9	1402.4	899.3	742.5
	13	1442.7	1412.8	1459.3	935.7	777.1
1200	10	1432.3	1400.5	1459.7	935.1	772.1
	13	1506.6	1470.4	1536.2	984.2	819.0
	15	1555.9	1515.9	1589.5	1020.2	854.6
				TO FEEDLOT		
850	7	1570.8	1484.9			
	9	1638.2	1548.9			
	11	1704.8	1612.1			
	13	1770.4	1674.7			
950	8	1804.7	1709.8			
	10	1873.1	1774.9			
	12	1940.8	1839.4			
1050	9	1864.8	1770.7			
	11	1929.1	1831.9			
	13	1992.7	1892.4			
1200	10	1917.4	1825.2			
	13	1988.9	1893.0			
	15	2019.6	1922.6			
				TO SLAUGHTER		
850	7	1758.3	1667.5	1712.6	1310.0	1175.9
	9	1828.0	1733.9	1783.0	1363.8	1225.8
	11	1896.5	1700.1	1852.9	1416.0	1274.4
	13	1963.3	1863.1	1922.3	1466.4	1322.1
950	8	2022.2	1923.5	1952.0	1499.1	1351.3
	10	2092.4	1989.8	2024.0	1552.6	1401.8
	12	2161.5	2055.8	2096.0	1604.1	1451.2
1050	9	2073.6	1975.8	2017.6	1534.5	1379.7
	11	2138.5	2037.7	2085.7	1582.6	1425.8
	13	2201.9	2098.4	2153.3	1629.8	1471.0
1200	10	2107.2	2012.3	2079.8	1558.8	1396.0
	13	2173.4	2075.1	2161.5	1607.2	1442.7
	15	2194.9	2095.4	2195.8	1626.6	1461.0

TABLE 23. ACREAGE REQUIREMENTS, 1000 BROOD COW HERD. UNIFORM WEANING RATE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV	V
		AT WEANING				
850	7	1098.8	1077.4	1107.7	707.7	574.3
	9	1154.0	1131.5	1162.5	744.6	607.0
	11	1210.9	1187.3	1219.5	782.6	641.1
	13	1269.2	1244.6	1278.6	821.2	676.7
950	8	1239.4	1216.0	1246.2	601.8	653.8
	10	1297.4	1272.9	1307.5	838.6	686.7
	12	1356.9	1331.4	1367.3	877.6	725.1
1050	9	1338.6	1314.4	1351.9	667.0	711.9
	11	1397.6	1372.5	1411.3	905.3	747.6
	13	1458.4	1432.0	1437.0	944.9	785.0
1200	10	1465.5	1440.4	1487.2	953.6	788.0
	13	1552.4	1525.6	1574.2	1009.7	841.0
	15	1614.9	1587.2	1638.2	1052.3	582.9
		AT FEEDLOT				
850	7	1535.9	1451.9			
	9	1619.8	1531.5			
	11	1704.3	1612.1			
	13	1790.8	1693.9			
950	8	1745.3	1653.5			
	10	1831.6	1735.5			
	12	1919.0	1818.3			
1050	9	1886.2	1791.1			
	11	1973.9	1874.4			
	13	2062.9	1959.1			
1200	10	2057.4	1958.5			
	13	2187.4	2082.1			
	15	2278.0	2168.8			
		AT SLAUGHTER				
850	7	1712.8	1624.2	1678.2	1278.2	1144.8
	9	1804.0	1711.2	1764.8	1346.8	1209.3
	11	1896.5	1799.2	1852.9	1416.0	1274.4
	13	1989.6	1888.2	1942.6	1485.4	1340.7
950	8	1944.8	1849.5	1893.0	1444.3	1297.6
	10	2038.4	1938.2	1982.6	1513.9	1364.0
	12	2133.3	2028.9	2074.2	1583.8	1431.3
1050	9	2101.5	2002.5	2039.0	1554.2	1399.0
	11	2196.6	2093.5	2130.1	1624.1	1466.5
	13	2292.3	2185.6	2223.2	1695.1	1535.0
1200	10	2289.0	2186.9	2215.6	1686.3	1521.0
	13	2430.3	2321.8	2357.0	1790.3	1621.6
	15	2528.6	2415.9	2450.1	1864.7	1694.8

TABLE 24. POUNDS BEEF SOLD PER ACRE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV	V
				TO WEANING		
850	7	332.0	337.9	329.6	515.7	635.2
	9	346.7	353.3	344.3	537.5	659.2
	11	356.3	365.4	355.7	554.6	676.7
	13	367.0	374.6	364.2	567.1	686.3
950	8	349.5	355.2	347.1	540.5	662.6
	10	361.4	367.7	356.9	559.4	681.0
	12	370.7	377.5	367.9	573.3	693.6
1050	9	362.9	369.9	359.2	560.2	682.3
	11	370.7	378.2	366.8	572.0	692.7
	13	376.7	384.7	372.4	560.8	699.3
1200	10	382.4	391.1	375.2	585.7	709.3
	13	390.1	399.7	382.6	597.2	717.7
	15	393.1	403.5	384.8	599.5	715.7
				TO FEEDLOT		
850	7	419.4	430.2			
	9	417.7	429.2			
	11	415.2	427.0			
	13	411.8	424.3			
950	8	420.1	432.1			
	10	417.8	430.6			
	12	415.3	428.7			
1050	9	421.7	435.8			
	11	418.7	433.1			
	13	415.3	429.8			
1200	10	427.2	442.8			
	13	421.8	437.8			
	15	417.2	433.4			
				TO SLAUGHTER		
850	7	425.6	436.8	410.8	537.1	598.4
	9	421.9	433.6	408.2	533.6	593.7
	11	417.8	429.5	404.5	529.3	588.1
	13	413.0	425.4	400.5	525.0	582.4
950	8	422.5	434.2	408.5	531.9	590.0
	10	418.8	431.3	405.8	529.1	586.0
	12	415.0	427.8	402.5	526.0	581.4
1050	9	422.6	435.8	404.6	532.0	591.7
	11	418.1	431.8	401.2	528.7	586.8
	13	413.7	427.5	396.9	524.8	581.0
1200	10	426.0	440.6	403.7	538.7	601.7
	13	419.5	434.5	397.0	533.6	594.8
	15	414.4	429.7	391.6	528.6	588.5

TABLE 25. POUNDS BEEF SOLD PER ACRE. UNIFORM WEANING RATE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV	V
				AT WEANING		
850	7	338.0	344.7	335.3	524.8	646.7
	9	348.9	355.8	346.3	540.7	663.3
	11	358.3	365.4	355.7	554.3	676.7
	13	366.4	373.6	363.7	566.3	687.2
950	8	356.5	363.4	353.7	551.1	675.8
	10	364.6	371.6	361.8	564.1	686.9
	12	371.6	378.8	368.7	574.1	695.4
1050	9	360.4	367.0	356.8	556.4	677.6
	11	367.0	373.8	363.9	566.6	686.1
	13	373.1	380.0	369.4	575.8	693.1
1200	10	363.9	370.2	358.6	559.2	676.7
	13	373.5	380.0	368.3	574.2	689.4
	15	378.3	384.9	372.9	580.3	692.0
				AT FEEDLOT		
850	7	420.7	432.0			
	9	417.9	429.7			
	11	415.2	427.0			
	13	412.2	424.6			
950	8	421.4	434.2			
	10	418.1	431.5			
	12	415.2	428.7			
1050	9	421.0	434.9			
	11	418.0	432.1			
	13	414.9	429.2			
1200	10	420.1	434.6			
	13	416.2	430.9			
	15	413.2	427.9			
				AT SLAUGHTER		
850	7	426.5	438.2	410.2	538.5	601.3
	9	422.1	433.9	407.5	534.0	594.7
	11	417.8	429.5	404.5	529.3	588.1
	13	413.5	425.6	401.7	525.4	582.1
950	8	423.6	435.9	407.5	534.2	594.6
	10	419.0	431.9	404.7	530.0	588.2
	12	414.8	427.8	401.7	526.1	582.2
1050	9	422.0	435.0	404.6	530.8	589.7
	11	417.5	430.8	401.8	527.0	583.7
	13	413.4	426.8	398.6	522.8	577.3
1200	10	419.5	433.0	401.5	527.5	584.9
	13	414.0	427.7	396.9	522.6	577.0
	15	410.1	423.8	394.2	518.0	569.9

TABLE 26. POUNDS TDN PER POUND BEEF SOLD.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV	V
				TO WEANING		
850	7	12.09	12.03	12.14	10.85	9.82
	9	11.59	11.53	11.61	10.41	9.46
	11	11.23	11.18	11.22	10.10	9.21
	13	10.98	10.93	10.95	9.89	9.06
950	8	11.50	11.46	11.50	10.33	9.35
	10	11.13	11.09	11.11	9.99	9.10
	12	10.87	10.83	10.83	9.77	8.93
1050	9	11.19	11.16	11.13	10.04	9.12
	11	10.97	10.93	10.95	9.85	8.98
	13	10.81	10.77	10.77	9.72	8.89
1200	10	10.75	10.73	10.80	9.69	8.81
	13	10.57	10.55	10.58	9.54	8.71
	15	10.54	10.52	10.55	9.54	8.74
				TO FEEDLOT		
850	7	10.25	10.42			
	9	10.30	10.46			
	11	10.37	10.52			
	13	10.46	10.59			
950	8	10.27	10.43			
	10	10.33	10.46			
	12	10.39	10.52			
1050	9	10.25	10.37			
	11	10.33	10.44			
	13	10.42	10.52			
1200	10	10.14	10.23			
	13	10.27	10.35			
	15	10.40	10.47			
				TO SLAUGHTER		
850	7	9.75	9.26	8.61	7.94	7.39
	9	9.85	9.96	8.66	8.00	7.48
	11	9.96	10.07	8.74	8.10	7.58
	13	10.09	10.18	8.84	8.20	7.69
950	8	9.85	9.97	8.66	8.01	7.48
	10	9.95	10.05	8.72	8.08	7.56
	12	10.05	10.14	8.79	8.16	7.66
1050	9	9.89	9.98	8.82	8.14	7.59
	11	10.01	10.09	8.90	8.23	7.69
	13	10.12	10.20	9.00	8.34	7.81
1200	10	9.87	9.93	8.97	8.25	7.67
	13	10.04	10.10	9.12	8.40	7.83
	15	10.19	10.25	9.29	8.57	8.01

TABLE 27. INDEXED COST PER POUND TDN CONSUMED.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM			
		I	II	III	IV
			AT WEANING (Index 1.000=$.0291)		
850	7	.725	.674	.745	.897
	9	.722	.663	.739	.887
	11	.715	.656	.729	.887
	13	.711	.649	.722	.893
950	8	.708	.656	.722	.880
	10	.704	.649	.715	.887
	12	.701	.646	.718	.897
1050	9	.718	.660	.732	.914
	11	.718	.653	.725	.924
	13	.715	.646	.718	.935
1200	10	.735	.660	.746	.962
	13	.735	.653	.739	.979
	15	.739	.653	.742	1.000
			AT FEEDLOT (Index 1.000=$.0243)		
850	7	1.000	.819		
	9	.996	.811		
	11	.988	.802		
	13	.984	.798		
950	8	.988	.802		
	10	.979	.798		
	12	.963	.790		
1050	9	.984	.798		
	11	.979	.794		
	13	.971	.790		
1200	10	.979	.798		
	13	.975	.790		
	15	.975	.790		
			AT SLAUGHTER (Index 1.000=$.0391)		
850	7	.711	.604	.893	1.000
	9	.703	.598	.885	.992
	11	.698	.591	.875	.985
	13	.693	.586	.862	.982
950	8	.703	.596	.887	1.000
	10	.698	.591	.885	.997
	12	.691	.583	.867	.997
1050	9	.696	.588	.882	.990
	11	.683	.580	.852	.987
	13	.663	.575	.841	.987
1200	10	.683	.575	.826	.974
	13	.675	.568	.808	.972
	15	.670	.563	.795	.969

TABLE 28. INDEXED COST PER POUND BEEF SOLD.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV
		AT WEANING (Index 1.000=$.2829)			
850	7	.901	.832	.932	1.000
	9	.859	.788	.880	.951
	11	.827	.755	.842	.921
	13	.804	.731	.812	.908
950	8	.839	.776	.854	.936
	10	.807	.743	.816	.913
	12	.784	.718	.787	.903
1050	9	.829	.756	.843	.946
	11	.809	.733	.816	.939
	13	.793	.716	.795	.936
1200	10	.812	.728	.828	.960
	13	.798	.710	.804	.962
	15	.803	.709	.806	.982
		AT FEEDLOT (Index 1.000=$.2495)			
850	7	.999	.829		
	9	.998	.825		
	11	.998	.824		
	13	1.000	.822		
950	8	.983	.815		
	10	.987	.812		
	12	.988	.810		
1050	9	.982	.806		
	11	.984	.806		
	13	.987	.808		
1200	10	.967	.794		
	13	.974	.798		
	15	.986	.807		
		AT SLAUGHTER (Index 1.000=$.3247)			
850	7	.835	.718	.925	.957
	9	.836	.717	.922	.956
	11	.838	.726	.920	.959
	13	.841	.717	.918	.968
950	8	.834	.715	.925	.965
	10	.836	.713	.929	.970
	12	.837	.714	.919	.979
1050	9	.826	.706	.916	.969
	11	.830	.706	.913	.979
	13	.833	.707	.912	.991
1200	10	.811	.689	.893	.968
	13	.816	.690	.889	.983
	15	.823	.695	.891	1.000

TABLE 29. INDEXED COST PER POUND BEEF SOLD. UNIFORM WEANING RATE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM			
		I	II	III	IV
		AT WEANING (Index 1.000=$.2824)			
850	7	.899	.824	.932	1.000
	9	.861	.787	.884	.955
	11	.828	.777	.843	.922
	13	.801	.730	.808	.904
950	8	.842	.769	.858	.940
	10	.813	.743	.823	.920
	12	.789	.720	.792	.909
1050	9	.830	.760	.843	.947
	11	.806	.737	.813	.936
	13	.734	.716	.786	.927
1200	10	.820	.752	.833	.969
	13	.769	.723	.794	.954
	15	.779	.713	.780	.958
		AT FEEDLOT (Index 1.000=$.2491)			
850	7	.999	.829		
	9	.999	.826		
	11	.999	.825		
	13	1.000	.823		
950	8	.988	.815		
	10	.990	.813		
	12	.990	.813		
1050	9	.984	.809		
	11	.986	.809		
	13	.987	.808		
1200	10	.980	.806		
	13	.984	.807		
	15	.990	.812		
		AT SLAUGHTER (Index 1.000=$.3329)			
850	7	.811	.696	.898	.929
	9	.814	.698	.896	.931
	11	.817	.699	.896	.937
	13	.820	.700	.897	.945
950	8	.810	.692	.895	.935
	10	.813	.694	.902	.943
	12	.816	.695	.895	.954
1050	9	.809	.691	.897	.948
	11	.813	.693	.897	.959
	13	.816	.694	.898	.971
1200	10	.809	.690	.898	.968
	13	.814	.694	.899	.983
	15	.821	.699	.905	1.000

TABLE 30. INDEXED NET RETURNS PER 1000 BROOD COW HERD, HIGH-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM			
		I.	II.	III	IV
			AT WEANING (Index 1.000=$124100)		
850	7	.521	.580	.496	.439
	9	.618	.681	.596	.532
	11	.703	.774	.689	.610
	13	.781	.859	.773	.672
950	8	.711	.773	.696	.614
	10	.805	.874	.795	.691
	12	.691	.966	.887	.753
1050	9	.742	.822	.726	.613
	11	.817	.905	.808	.664
	13	.686	.981	.884	.708
1200	10	.779	.683	.759	.594
	13	.853	.972	.845	.635
	15	.669	1.000	.865	.619
			AT FEEDLOT (Index 1.000=$204830)		
850	7	.683	.790		
	9	.708	.824		
	11	.730	.852		
	13	.747	.878		
950	8	.807	.939		
	10	.830	.972		
	12	.852	1.000		
1050	9	.801	.947		
	11	.817	.971		
	13	.830	.991		
1200	10	.784	.940		
	13	.782	.948		
	15	.756	.926		
			AT SLAUGHTER (Index 1.000=$205960)		
850	7	.709	.820	.558	.524
	9	.726	.845	.579	.540
	11	.740	.866	.595	.548
	13	.750	.884	.610	.550
950	8	.820	.955	.642	.592
	10	.635	.979	.653	.600
	12	.848	1.000	.681	.600
1050	9	.807	.955	.626	.557
	11	.815	.971	.641	.554
	13	.821	.983	.652	.546
1200	10	.782	.940	.607	.507
	13	.772	.939	.612	.485
	15	.741	.912	.593	.444

TABLE 31. INDEXED NET RETURNS PER 1000 BROOD COW HERD, LOW-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
		AT WEANING (Index 1.000=$76650)			
850	7	.332	.426	.290	.198
	9	.425	.530	.393	.268
	11	.590	.624	.486	.358
	13	.583	.709	.570	.406
950	8	.493	.595	.470	.337
	10	.587	.699	.571	.403
	12	.670	.793	.664	.448
1050	9	.568	.699	.544	.360
	11	.642	.735	.628	.395
	13	.709	.864	.706	.422
1200	10	.685	.854	.653	.385
	13	.765	.957	.752	.411
	15	.787	1.000	.781	.382
		AT FEEDLOT (Index 1.000=$166180)			
850	7	.650	.788		
	9	.675	.823		
	11	.696	.852		
	13	.712	.879		
950	8	.770	.937		
	10	.792	.971		
	12	.813	.999		
1050	9	.772	.956		
	11	.788	.980		
	13	.800	1.000		
1200	10	.771	.966		
	13	.770	.975		
	15	.745	.956		
		AT SLAUGHTER (Index 1.000=$205960)			
850	7	.709	.820	.558	.524
	9	.726	.845	.579	.540
	11	.740	.866	.595	.548
	13	.750	.884	.610	.550
950	8	.820	.955	.642	.592
	10	.835	.979	.653	.600
	12	.848	1.000	.681	.600
1050	9	.807	.955	.626	.557
	11	.815	.971	.641	.554
	13	.821	.983	.652	.546
1200	10	.782	.940	.607	.507
	13	.772	.939	.612	.485
	15	.741	.912	.593	.444

TABLE 32. INDEXED NET RETURNS PER 1000 BROOD COW HERD, HIGH-LOW PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
		AT WEANING (Index 1000=$124100)			
850	7	.521	.580	.496	.439
	9	.616	.681	.596	.532
	11	.703	.774	.689	.610
	13	.781	.859	.773	.672
950	8	.711	.773	.696	.614
	10	.805	.874	.795	.691
	12	.891	.966	.887	.753
1050	9	.742	.822	.726	.613
	11	.817	.905	.808	.564
	13	.886	.981	.864	.708
1200	10	.779	.883	.759	.594
	13	.853	.972	.845	.635
	15	.869	1.000	.865	.619
		AT FEEDLOT (Index 1.000=$145030)			
850	7	.613	.779		
	9	.637	.814		
	11	.657	.843		
	13	.672	.870		
950	8	.727	.926		
	10	.749	.960		
	12	.769	.990		
1050	9	.737	.954		
	11	.752	.979		
	13	.764	1.000		
1200	10	.751	.980		
	13	.751	.992		
	15	.727	.974		
		AT SLAUGHTER (Index 1.000=$129950)			
850	7	.616	.810	.415	.361
	9	.631	.837	.435	.373
	11	.642	.858	.450	.374
	13	.649	.876	.464	.367
950	8	.710	.940	.476	.358
	10	.723	.967	.481	.397
	12	.734	.990	.514	.386
1050	9	.719	.966	.483	.374
	11	.724	.984	.498	.360
	13	.728	.998	.509	.341
1200	10	.735	.995	.507	.349
	13	.727	1.000	.519	.317
	15	.699	.979	.506	.271

TABLE 33. INDEXED NET RETURNS PER POUND BEEF SOLD, HIGH-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
		AT WEANING (Index 1.000=$2376)			
850	7	.740	.623	.704	.623
	9	.801	.886	.776	.691
	11	.846	.932	.830	.734
	13	.879	.967	.870	.756
950	8	.846	.923	.830	.732
	10	.890	.967	.880	.765
	12	.922	1.000	.918	.779
1050	9	.800	.888	.784	.662
	11	.829	.919	.821	.675
	13	.851	.943	.849	.679
1200	10	.743	.842	.724	.566
	13	.758	.864	.751	.564
	15	.742	.854	.739	.529
		AT FEEDLOT (Index 1.000=$2603)			
850	7	.815	.973		
	9	.814	.975		
	11	.812	.974		
	13	.806	.973		
950	8	.838	1.000		
	10	.835	1.000		
	12	.831	.998		
1050	9	.801	.966		
	11	.796	.963		
	13	.790	.959		
1200	10	.753	.916		
	13	.734	.900		
	15	.706	.875		
		AT SLAUGHTER (Index 1.000=$.2352)			
850	7	.829	.986	.694	.652
	9	.824	.985	.606	.649
	11	.808	.981	.696	.640
	13	.810	.977	.695	.626
950	8	.840	1.000	.705	.651
	10	.834	.999	.696	.639
	12	.828	.996	.707	.623
1050	9	.807	.971	.671	.598
	11	.798	.966	.671	.580
	13	.789	.960	.668	.559
1200	10	.763	.929	.633	.529
	12	.741	.912	.625	.495
	15	.713	.887	.604	.453

TABLE 34. INDEXED NET RETURNS PER POUND BEEF SOLD, LOW-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
		AT WEANING (Index 1.000=$.1253)			
850	7	.551	.709	.484	.330
	9	.647	.807	.598	.438
	11	.717	.880	.685	.505
	13	.769	.935	.751	.536
950	8	.690	.832	.656	.470
	10	.760	.905	.740	.522
	12	.812	.961	.804	.543
1050	9	.718	.883	.668	.456
	11	.764	.933	.747	.470
	13	.798	.972	.795	.475
1200	10	.765	.954	.729	.430
	13	.796	.996	.782	.428
	15	.788	1.000	.781	.383
		AT FEEDLOT (Index 1.000=$.2134)			
650	7	.777	.972		
	9	.777	.975		
	11	.775	.975		
	13	.769	.974		
950	8	.800	.999		
	10	.798	1.000		
	12	.795	.999		
1050	9	.773	.976		
	11	.769	.973		
	13	.762	.969		
1200	10	.741	.941		
	13	.723	.927		
	15	.696	.903		
		AT SLAUGHTER (Index 1.000=$.2352)			
850	7	.829	.986	.694	.652
	9	.824	.985	.696	.649
	11	.808	.981	.696	.640
	13	.810	.977	.695	.626
950	8	.840	1.000	.705	.651
	10	.834	.999	.696	.639
	12	.828	.996	.707	.623
1050	9	.807	.971	.671	.598
	11	.798	.966	.671	.580
	13	.789	.960	.668	.559
1200	10	.763	.929	.633	.529
	12	.741	.912	.625	.495
	15	.713	.887	.604	.453

TABLE 35. INDEXED NET RETURNS PER POUND BEEF SOLD, HIGH-LOW PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV
		AT WEANING (Index 1.000=$.2376)			
850	7	.740	.823	.704	.623
	9	.801	.886	.776	.691
	11	.846	.932	.830	.734
	13	.879	.967	.870	.756
950	8	.846	.923	.830	.732
	10	.890	.967	.880	.765
	12	.922	1.000	.918	.779
1050	9	.800	.888	.784	.662
	11	.829	.919	.821	.675
	13	.851	.943	.849	.679
1200	10	.743	.842	.724	.566
	13	.758	.864	.751	.564
	15	.742	.854	.739	.529
		AT FEEDLOT (Index 1.000=$.1821)			
850	7	.741	.971		
	9	.741	.975		
	11	.740	.976		
	13	.735	.976		
950	8	.763	.998		
	10	.762	1.000		
	12	.759	1.000		
1050	9	.746	.985		
	11	.742	.983		
	13	.735	.979		
1200	10	.730	.965		
	13	.713	.953		
	15	.687	.930		
		AT SLAUGHTER (Index 1.000=$.1465)			
850	7	.730	.987	.524	.455
	9	.726	.988	.530	.454
	11	.719	.986	.532	.443
	13	.710	.983	.534	.423
950	8	.737	.999	.530	.443
	10	.732	1.000	.536	.429
	12	.726	.996	.540	.406
1050	9	.728	.995	.524	.406
	11	.719	.992	.528	.382
	13	.709	.987	.528	.354
1200	10	.725	.996	.536	.369
	13	.706	.984	.537	.328
	15	.682	.964	.522	.280

TABLE 36. INDEXED NET RETURNS PER ACRE, HIGH-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	II	III	IV
		AT WEANING (Index 1.000=$106.15)			
850	7	.550	.623	.519	.719
	9	.622	.700	.597	.832
	11	.679	.762	.660	.911
	13	.722	.811	.709	.960
950	8	.663	.733	.645	.886
	10	.720	.796	.707	.957
	12	.765	.845	.756	1.000
1050	9	.650	.735	.630	.829
	11	.688	.778	.674	.864
	13	.718	.812	.708	.885
1200	10	.636	.737	.608	.742
	13	.662	.773	.643	.754
	15	.653	.771	.636	.709
		AT FEEDLOT (Index 1.000=$112.50)			
850	7	.791	.969		
	9	.787	.968		
	11	.780	.963		
	13	.768	.955		
950	8	.815	1.000		
	10	.807	.997		
	12	.799	.990		
1050	9	.782	.974		
	11	.771	.965		
	13	.759	.953		
1200	10	.744	.938		
	13	.716	.912		
	15	.682	.877		
		AT SLAUGHTER (Index 1.000=$109.66)			
850	7	.815	.984	.803	1.000
	9	.802	.974	.799	.991
	11	.788	.961	.791	.972
	13	.771	.947	.781	.946
950	8	.820	.993	.811	.994
	10	.807	.983	.797	.975
	12	.793	.971	.799	.950
1050	9	.786	.964	.764	.921
	11	.769	.950	.756	.894
	13	.752	.934	.745	.862
1200	10	.746	.928	.711	.830
	13	.713	.898	.690	.779
	15	.677	.863	.658	.717

TABLE 37. INDEXED NET RETURNS PER ACRE, UNIFORM WEANING RATE, HIGH-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
		AT WEANING (Index 1.000=$104.34)			
850	7	.551	.632	.517	.713
	9	.625	.708	.599	.832
	11	.691	.775	.672	.927
	13	.749	.835	.736	1.000
950	8	.653	.736	.632	.862
	10	.711	.777	.697	.939
	12	.765	.850	.755	.996
1050	9	.668	.750	.649	.856
	11	.719	.802	.706	.911
	13	.767	.851	.758	.961
1200	10	.675	.758	.654	.813
	13	.746	.828	.731	.892
	15	.779	.861	.767	.915
		AT FEEDLOT (Index 1.000=$110.46)			
850	7	.790	.972		
	9	.792	.978		
	11	.794	.980		
	13	.794	.984		
950	8	.805	.995		
	10	.804	.997		
	12	.804	.998		
1050	9	.804	1.000		
	11	.803	1.000		
	13	.802	1.000		
1200	10	.798	.994		
	13	.796	.994		
	15	.790	.987		
		AT SLAUGHTER (Index 1.000=$107.38)			
850	7	.818	.992	.801	1.000
	9	.811	.987	.806	1.000
	11	.805	.981	.807	.992
	13	.797	.977	.810	.981
950	8	.816	.995	.802	.985
	10	.807	.989	.805	.974
	12	.801	.983	.806	.957
1050	9	.810	.991	.789	.950
	11	.801	.985	.790	.934
	13	.794	.978	.790	.916
1200	10	.796	.979	.768	.897
	13	.786	.970	.770	.877
	15	.775	.959	.763	.851

TABLE 38. INDEXED NET RETURNS PER ACRE, LOW-HIGH PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM			
		I	II	III	IV
			AT WEANING (Index 1.000=$50.57)		
850	7	.454	.594	.395	.421
	9	.556	.706	.510	.583
	11	.637	.797	.604	.694
	13	.699	.868	.678	.752
950	8	.597	.732	.564	.630
	10	.680	.825	.658	.723
	12	.746	.899	.733	.771
1050	9	.646	.810	.612	.632
	11	.701	.874	.679	.666
	13	.745	.926	.733	.683
1200	10	.725	.924	.678	.624
	13	.770	.987	.741	.633
	15	.767	1.000	.744	.569
			AT FEEDLOT (Index 1.000=$92.12)		
850	7	.755	.968		
	9	.751	.969		
	11	.745	.964		
	13	.734	.957		
950	8	.779	1.000		
	10	.772	.998		
	12	.764	.992		
1050	9	.755	.985		
	11	.745	.976		
	13	.733	.965		
1200	10	.734	.956		
	13	.706	.940		
	15	.673	.907		
			AT SLAUGHTER (Index 1.000=$109.66)		
850	7	.815	.984	.803	1.000
	9	.802	.974	.799	.991
	11	.788	.961	.791	.972
	13	.771	.947	.781	.946
950	8	.820	.993	.811	.994
	10	.807	.983	.797	.975
	12	.793	.971	.799	.950
1050	9	.786	.964	.764	.921
	11	.769	.950	.756	.894
	13	.752	.934	.745	.862
1200	10	.746	.928	.711	.830
	13	.713	.898	.690	.779
	15	.677	.863	.658	.717

TABLE 39. INDEXED NET RETURNS PER ACRE, HIGH-LOW PRICE STRUCTURE.

COW SIZE (lbs.)	MILK LEVEL (lbs./day)	SYSTEM I	SYSTEM II	SYSTEM III	SYSTEM IV
			AT WEANING (Index 1.000=$106.15)		
850	7	.550	.623	.519	.719
	9	.622	.700	.597	.832
	11	.679	.722	.660	.911
	13	.722	.811	.709	.960
950	8	.663	.733	.645	.886
	10	.720	.796	.707	.957
	12	.765	.845	.756	1.000
1050	9	.650	.735	.630	.829
	11	.688	.779	.674	.864
	13	.718	.812	.708	.855
1200	10	.536	.737	.608	.742
	13	.662	.773	.643	.754
	15	.653	.771	.636	.709
			AT FEEDLOT (Index 1.000=$78.53)		
850	7	.721	.968		
	9	.718	.970		
	11	.712	.966		
	13	.701	.960		
950	8	.744	1.000		
	10	.738	.999		
	12	.731	.994		
1050	9	.730	.995		
	11	.720	.987		
	13	.708	.976		
1200	10	.723	.992		
	13	.697	.968		
	15	.665	.935		
			AT SLAUGHTER (Index 1.000=$70.22)		
850	7	.740	.993	.747	.899
	9	.727	.985	.747	.892
	11	.713	.972	.741	.871
	13	.700	.959	.735	.841
950	8	.742	1.000	.754	.884
	10	.729	.992	.739	.863
	12	.716	.981	.749	.831
1050	9	.728	.984	.726	.825
	11	.711	.980	.722	.790
	13	.694	.964	.712	.751
1200	10	.723	.995	.706	.757
	13	.691	.967	.691	.697
	15	.658	.935	.662	.627

TABLE 40. BUDGET: OVERHEAD AND FIXED EXPENSES FOR 1000 BROOD COW OPERATION.

Foreman	$10,000
Herdsman	8,000
Part-time Labor	5,000
Insurance	3,000
Taxes	5,000
Utilities and Telephone	1,500
Accounting and Legal Fees	1,500
Transportation[a]	4,500
Supplies and Hardward	1,500
Depreciation and Repairs[b]	5,000
	$45,000

[a] 30,000 miles at 15c/mile

[b]For buildings and fences

APPENDIX B

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*
*                      **************** MODEL I ******************
*                      *                                         *
*                      *        COW EFFICIENCY ESTIMATOR         *
*                      *                                         *
*                      *******************************************
*
*
*                      *-----------------------------------------*
*                      *  THE FOLLOWING ARE CONSTANTS AND TABLES *
*                      *         USED IN THE INITIAL RUN         *
*                      *-----------------------------------------*
*
C PCTMCW=100                            PCT MATURE COW WEIGHT
C MCW=1047                              MATURE COW WEIGHT (LBS)
T WFT=0/1.07/1.09/1.10/1.00/0.95/0.96/0.97/0.98/0.99/1.00/1.02/1.04/0.00
* WFT=                                  WEIGHT FACTOR TABLE
C CWADG=0.1                             COW ADG (LBS)
C DMYFM=12                              DAILY MILK YIELD, FIRST MONTH (LBS)
T MYFT=0.000/0.000/0.000/0.000/1.00/0.97/0.92/0.84/0.78/0.73/0.69/0.65/0
X .60/0.00/0.00/0.00/0.00
* MYFT=                                 MILK YIELD FACTOR TABLE
C AFCOW=1.4                             ACTIVITY FACTOR, COW
C BRTHWT=65                             BIRTH WEIGHT OF CALF (LBS)
T COWFQIT=0/5/5/7/7/7/5/5/4/3.5/3.5/3/5
* COWFQIT=              COW FEED QUALITY INDEX TABLE
T MOTAB=00000/10/11/12/1/2/3/4/5/6/7/8/9/10/11/12/1/2/3/4/5/6/7/8/9/10/1
X 1/12/1/2/3/4/5/6/7/8/9
* MOTAB=          MONTH TABLE (TO SYNCHRONIZE TIME BY MONTHS)
T CADGT=0.0/0.00/0.00/1.89/1.89/1.89/1.89/1.89/1.89/1.89/1.89/1.00/1.50/
X 2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07/2.07
X /0/0/0/0/0/0/0/0/00/0
* CADGT=                                TABLE OF CALF AVERAGE DAILY GAIN
T FIT=0/0/0/0/1/1/1/1/1
* FIT=                                  FACTOR 1 TABLE
C SLWT=1400                             SLAUGHTER WEIGHT
T CBWTAB=0/0/0/01/0/0/0/0/0
* CBWTAB             CALF BIRTH WEIGHT TABLE (INITIATES CALF BIRTH)
C FLTAGE=9
C WN_AGE=9                              WEANING AGE (MONTHS)
C PAF=1.4                               PASTURE ACTIVITY FACTOR FOR CALVES
C FLAF=1.1                              FEEDLOT ACTIVITY FACTOR
C FLFQI=9                               FEEDLOT FEED QUALITY INDEX
T STCFQIT=0/7/7/7/7/7/6/6/6/5/5/5/7
* STCFQIT=                 STOCKER FEED QUALITY INDEX TABLE
T CCPTCT=.0000/.01/.01/.01/.01/.01/.01/.01/.01/.01/.01/.01/.01
* CCPTCT=                  COW-CALF PASTURE TDN COST TABLE
T CCSTCT=0/.039/.039/.039/.039/.039/.039/.039/.039/.039/.039/.039/.039
* CCSTCT=                  COW-CALF SUPPLEMENT TDN COST TABLE
T AUMTAB=0/0/0.6/0.9/1.0/1.1/1.2/1.2/1.0/0.8/0.4/0.0/0.0
* AUMTAB=              TABLE OF AVAILABLE ANIMAL UNIT MONTHS OF GRAZING
C TDNPAUM=600       TDN/AUM IN LBS (1000# COW, 11# MILK/D, 350# CALF)
T PSRTAB=0/1.30/1.30/1.30/1.30/1.30/1.30/1.30/1.30/1.30/1.30/1.30/1.30
C ACMC=20.61                            ANNUAL COW MAINTENANCE COSTS ($/YR)
T CSTFTAB=0/.0313/.0313/.0313/.0313/.0313/.0205/.0205/.0205/.0205/.0390/
X .0390/.0313
* CSTFTAB=           COST OF STOCKER FEED TABLE
T CFRTAB=0000/.069/.069/.069/.069/.069/.069/.069/.069/.069/.069/.069/.06
X 9/.069
* CFTTAB=                         COST OF FEEDLOT RATION TABLE
C CLFMC=0.88                              CALF MAINTENANCE COSTS ($/MONTH)
C F=1                                   CALF FEEDING SYSTEM (PASTURE=0,FDLT=1)
C P=0                                   CALF FEEDING SYSTEM (PASTURE=1,FDLT=0)
T CPTAB=.50/.50/.50/.50/.50/.50/.50/.50/.50/.50/.50/.50/.50
* CPTAB=                                CALF PRICE TABLE
T SFITAB=0/0/0/0/0/0/0/0/0/0/0/0/0      STOCKER FACTOR
*
*                      *-----------------------------------------*
*                      *             SOURCE PROGRAM              *
*                      *-----------------------------------------*
*
NOTE                          ****SECTOR A****
NOTE             DETERMINATION OF COW ENERGY REQUIREMENTS
A COWWTK.K=COWWT.K*.4536                COW WEIGHT (KG)
A COWWT.K=(PCTMCW*.01*MCW+CCG.K)*WTFAC.K*.01 COW WEIGHT
* PCTMCW=                               PCT MATURE COW WEIGHT
* MCW=                                  MATURE COW WEIGHT (LBS)
A WTFAC.K=TABHL(WFT,TIME.K,0,13,1)      WEIGHT FACTOR
* WFT=                                  WEIGHT FACTOR TABLE
L CCG.K=CCG.J+DT*(CWADG*30.417)         CUMULATIVE COW GAIN (LBS)
N CCG=0
* CWADG=                                COW ADG (LBS)
A MY.K=DMYFM*MYFAC.K                    MILK YIELD (LBS/DAY)
* DMYFM=                                DAILY MILK YIELD, FIRST MONTH (LBS)
A MYFAC.K=TABHL(MYFT,TIME.K,0,16,1)      MILK YIELD FACTOR
* MYFT=                                 MILK YIELD FACTOR TABLE
A NEMCOW.K=AFCOW*.070*EXP(MBW.K)        NE, COW MAINTENANCE
A MBW.K=0.75*LOGN(COWWTK.K)             METABOLIC BODY WEIGHT
* AFCOW=                                ACTIVITY FACTOR, COW
A TDNCWMK.K=(NEMCOW.K*COWEFM.K)/3.6155  TDN FOR COW MAINTENANCE (KG/DAY)
A TDNCWML.K=TDNCWMK.K*2.2046             TDN FOR COW MAINTENANCE (LBS/DAY)
A COWEFM.K=TABLE(EFM,COWFQI.K,0,11,1) (1/EFFICIENCY FOR MAINTENANCE, COW
T EFM=0/1.99/1.91/1.84/1.76/1.72/1.67/1.62/1.57/1.52/1.49/0
A COWFQI.K=TABHL(COWFQIT,MONTH.K,0,12,1)
* COWFQIT=            COW FEED QUALITY INDEX TABLE
A MONTH.K=TABHL(MOTAB,TIME.K,0,36,1)
* MOTAB=           MONTH TABLE (TO SYNCHRONIZE TIME BY MONTHS)
A NEGCOW.K=(.05603*CWADG*.4536+0.1265*NEGCW1.K)*NEGCW2.K NE, COW GAIN
A NEGCW1.K=EXP(2*LOGN(CWADG*.4536))
A NEGCW2.K=EXP(MBW.K)
A TDNCWGK.K=(NEGCOW.K*COWEFG.K)/3.6155 TDN FOR COW GAIN (KG/DAY)
A TDNCWGL.K=TDNCWGK.K*2.2046           TDN FOR COW GAIN (LBS/DAY)
A COWEFG.K=TABLE(EFG,COWFQI.K,0,11,1) (1/EFFICIENCY FOR COW GAIN)
T EFG=0/5.21/4.44/3.89/3.46/3.13/3.00/2.60/2.40/2.22/2.08/0 (1/EFF GAIN)
A TDNMLKP.K=MY.K*MLKTDN*COWEMP.K        TDN FOR MILK PRODUCTION (LBS/DAY)
A COWEMP.K=TABLE(EMP,COWFQI.K,0,11,1) COW EFFICIENCY OF MILK PRODUCTION
T EMP=0/2.47/2.36/2.26/2.17/2.06/2.00/1.93/1.87/1.80/1.74/0
C MLKTDN=.156                          LBS TDN/LB MILK
A DTDNCOW.K=TDNCWML.K+TDNCWGL.K+TDNMLKP.K DAILY TDN PER COW (LBS)
A MTDNCOW.K=DTDNCOW.K*30.417           MONTHLY TDN PER COW (LBS)
NOTE                        ****SECTOR B****
NOTE            DETERMINATION OF CALF/STEER ENERGY REQUIREMENTS
L CLFWT.K=CLFWT.J+DT*(CFADGK.JK*30.417*2.2046) CALF WEIGHT (LBS)
N CLFWT=BRTHWT
* BRTHWT=                               BIRTH WEIGHT OF CALF (LBS)
* CADGT=                                TABLE OF CALF AVERAGE DAILY GAIN
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R CFADGK.KL=TABHL(CADGT,TIME.K,0,36,1)*F2.K*.4536+.001 CALF ADG
A CALFWT.K=CLFWT.K*F1.K*F2.K+.001   CALF WEIGHT (LBS)
A F1.K=TABHL(F1T,TIME.K,0,8,1)      FACTOR 1
* F1T=                              FACTOR 1 TABLE
A F2.K=CLIP(0,1,CLFWT.K,SLWT)       FACTOR 2
* F2T=                              FACTOR 2 TABLE
* SLWT=                             SLAUGHTER WEIGHT
A CLFWTK.K=CALFWT.K*.4536           CALF WEIGHT (KG)
A CLFADG.K=CFADGK.JK*2.2046*F1.K*F2.K CALF ADG (LB) (PRINT ONLY)
A CBW.K=TABHL(CBWTAB,TIME.K,0,8,1)*BRTHWT CALF BIRTH WEIGHT
* CBWTAB            CALF BIRTH WEIGHT TABLE (INITIATES CALF BIRTH)
A CALFWGT.K=CALFWT.K+CBW.K          CALF WEIGHT (LBS)
A NEMCALF.K=AFCALF.K*.070*EXP(CMBW.K) NE. CALF MAINTENANCE
A CMBW.K=0.75*LOGN(CLFWTK.K)        CALF METABOLIC BODY WEIGHT
A AFCALF.K=CLIP(PAF,FLAF,F_AG.K,TIME.K)*F1.K*F2.K CALF ACTIVITY FACTOR
A F_AG.K=FLTAGE+(12-WN_AGE)+.1      FEEDLOT AGE
* FLTAGE=                           FEEDLOT AGE (MONTHS)
* WN_AGE=                           WEANING AGE (MONTHS)
* PAF=                              PASTURE ACTIVITY FACTOR FOR CALVES
* FLAF=                             FEEDLOT ACTIVITY FACTOR
A TONCLMK.K=(NEMCALF.K*CALFEFM.K)/3.6155 TDN FOR CALF MAINTENANCE (KG/D)
A TONCLML.K=TONCLMK.K*2.2046        TDN FOR CALF MAINTENANCE (LBS/DAY)
A CALFEFM.K=TABLE(EFM,CALFFQI.K,0,11,1) CALF EFFICIENCY FOR MAINTENANCE
A CALFFQI.K=CLIP(PFLFQI.K,FLFQI,F_AG.K,TIME.K)*F1.K*F2.K CALF FQ INDEX
* FLFQI=                            FEEDLOT FEED QUALITY INDEX
A PFLFQI.K=CLIP(MLKFQI,STCFQI.K,MY.K,1) PREFEEDLOT FQI
C MLKFQI=10                         MILK FEED QUALITY INDEX
A STCFQI.K=TABHL(STCFQIT,MONTH.K,0,12,1) STOCKER CALF FEED QUALITY INDEX
* STCFQIT=                STOCKER FEED QUALITY INDEX TABLE
A NEGCALF.K=(.05272*CFADGK.JK+0.00682*NEGCLF1.K)*NEGCLF2.K NE. CALF GAIN
A NEGCLF1.K=EXP(2*LOGN(CFADGK.JK))
A NEGCLF2.K=EXP(MBWC.K)
A MBWC.K=0.75*LOGN(CLFWTK.K) METABOLIC BODY WT-CALF
A TONCLGK.K=(NEGCALF.K*CALFEFG.K)/3.6155 TDN FOR CALF GAIN (KG/DAY)
A TONCLGL.K=TONCLGK.K*2.2046        TDN FOR CALF GAIN (LBS/DAY)
A CALFEFG.K=TABLE(EFG,CALFFQI.K,0,11,1)  1/EFFICIENCY FOR CALF GAIN
A TDNMILK.K=MY.K*MLKTDN             TDN FROM MILK (LBS)
A DTONCLF.K=TONCLML.K+TONCLGL.K     DAILY TDN PER CALF (LBS)
A MTONCLF.K=DTONCLF.K*30.417        MONTHLY TDN PER CALF (LBS)
NOTE                    ****SECTOR C****
NOTE           CALCULATION OF EFFICIENCY OF BEEF PRODUCTION
NOTE
NOTE          DETERMINATION OF NUTRIENT EFFICIENCY OF BEEF PRODUCTION
NOTE
L CTONPM.K=CTONPM.J+DT*(NMTON.JK)  CUMULATIVE TDN-PRIOR MONTH
R NMTON.KL=MTONCOW.K+MTONCLF.K-TDNMILK.K*30.417 NET MONTHLY TDN
N CTONPM=0.1
A CUMTON.K=CTONPM.K+MTONCOW.K+MTONCLF.K-TDNMILK.K*30.417  CUMUL TDN
A CUMLTON.K=CUMTON.K*F2.K           CUMULATIVE TDN (LBS)
A NEBP.K=CALFWT.K/CUMTON.K          NUTRIENT EFFICIENCY OF BEEF PRODUCTION
NOTE
NOTE        DETERMINATION OF FEED AND MAINTENANCE COST FOR COW AND NURSING CALF
NOTE
A CCPTC.K=TABLE(CCPTCT,MONTH.K,0,12,1)  COW/CALF PASTURE TDN COST ($/LB TDN)
* CCPTCT=                 COW-CALF PASTURE TDN COST TABLE
A CCSTC.K=TABLE(CCSTCT,MONTH.K,0,12,1) COW/CALF SUPPLEMENT TDN COST ($/LB TDN)
* CCSTCT=                 COW-CALF SUPPLEMENT TDN COST TABLE
A NETTON.K=(MTONCOW.K+MTONCLF.K-TDNMILK.K*30.417)*F3.K NET COW/CALF TDN (LBS)
A SUPPL.K=(NETTON.K-AVPTON.K)*F3.K  SUPPLEMENTAL FEED (LBS)
A AVPTON.K=AVAUM.K*TONPAUM*PSR.K    AVAILABLE PASTURE TDN PER AU (LBS/MO)
A AVAUM.K=TABLE(AUMTAB,MONTH.K,0,12,1) AVAILABLE AU MONTHS OF GRAZING PER ACRE
* AUMTAB=            TABLE OF AVAILABLE ANIMAL UNIT MONTHS OF GRAZING
* TONPAUM=          TDN/AUM IN LBS (1000# COW, 11# MILK/D, 350# CALF)
A PSR.K=TABLE(PSRTAB,MONTH.K,0,12,1)  PASTURE STOCKING RATE (ACRES/AU)
* PSRTAB=                           PASTURE STOCKING RATE TABLE
A CSTSPL.K=CLIP(CCSTC.K,0,SUPPL.K,0)  COST OF SUPPLEMENT ($/LB TDN)
A SPLCST.K=CSTSPL.K*SUPPL.K*F3.K    SUPPLEMENT COST ($/MO)
A CCFC.K=(PTONC.K*CCPTC.K+SPLCST.K)*F3.K  COW/CALF FEED COSTS ($/MO)
A PTONC.K=CLIP(NETTON.K,PSTTONC.K,AVPTON.K,NETTON.K)*F3.K PASTURE TDN CHARGED-LB
A PSTTONC.K=NETTON.K-SUPPL.K*F3.K  PASTURE TDN CONSUMED (LBS/MO)
A PTONCST.K=PTONC.K*CCPTC.K*F3.K   PASTURN TDN COSTS ($/MO)
A CCFMC.K=CCFC.K+CMC.K*F3.K.        COW/CALF FEED AND MAINTENANCE COST ($/MO)
A CMC.K=(ACMC/12)*F3.K              COW MAINTENANCE COSTS ($/MO)
* ACMC=                             ANNUAL COW MAINTENANCE COSTS ($/YR)
NOTE
NOTE             DETERMINATION OF FEED AND MAINTENANCE COSTS OF CALF
NOTE                        FROM WEANING TO SLAUGHTER
NOTE
A CSTF.K=TABLE(CSTFTAB,MONTH.K,0,12,1)  COST OF STOCKER FEED ($/LB TDN)
* CSTFTAB=         COST OF STOCKER FEED TABLE
A CFR.K=TABHL(CFRTAB,CALFWGT.K,000,1300,100) COST FEEDLOT  RATION ($/LB TDN)
* CFRTAB=                   COST OF FEEDLOT RATION TABLE
A CFC.K=CLIP(CSTF.K,CFR.K,F_AG.K,TIME.K)*F4.K*F2.K*MTONCLF.K CALF FEED
NOTE                                                    COSTS ($/MONTH)
A CFMC.K=CFC.K+CLFMC*F2.K*F4.K*F1.K CALF FEED & MAINTENANCE COSTS ($/MO)
* CLFMC=                              CALF MAINTENANCE COSTS ($/MONTH)
A CALFMC.K=CLFMC*F2.K*F4.K*F1.K     CALF MAINTENANCE COSTS ($/MO)
A F3.K=CLIP(1,P,COWWT.K,1)          FACTOR 3
A F4.K=CLIP(0,F,COWWT.K,1)          FACTOR 4
* F=                                CALF FEEDING SYSTEM (PASTURE=0,FDLT=1)
* P=                                CALF FEEDING SYSTEM (PASTURE=1,FDLT=0)
NOTE
NOTE           CALCULATION OF COST EFFICIENCY OF BEEF PRODUCTION
NOTE
L CUMCPM.K=CUMCPM.J+DT*(CCFMC.J+CFMC.J) CUMULATIVE FEED COSTS-PRIOR MONTH
N CUMCPM=0
A CUMCOST.K=(CUMCPM.K+CCFMC.K+CFMC.K)*F2.K CUMULATIVE FEED COSTS ($)
A CEBP.K=(CUMCOST.K*F1.K)/(CALFWGT.K+.001) COST EFFIC OF BEEF PROD ($/LB)
A CPPG.K=(CFMC.K)/(.001+CLFADG.K*30.417)  COST PER LB GAIN
A CLFPRC.K=TABHL(CPTAB,CALFWGT.K,0,1300,100)*F2.K CALF PRICE ($/LB)
* CPTAB=                            CALF PRICE TABLE
A CLFVAL.K=CLFPRC.K*CALFWGT.K       CALF VALUE ($/CALF)
A PROFIT.K=CLFVAL.K-CUMCOST.K
A CPASTON.K=(CUMTON.K-CSUPTON.K)*F3.K CUMULATIVE PASTURE TDN
A CSUPTON.K=CSTONPM.K+MSUPP.K       CUMULATIVE SUPPLEMENT TDN
L CSTONPM.K=CSTONPM.J+DT*(SUPTON.JK) CUMULATIVE SUPPL TDN, PRIOR MONTH
N CSTONPM=0
R SUPTON.KL=MSUPP.K                 MONTHLY SUPPLEMENT TDN
A SUPADJ.K=CLIP(1,0,SUPPL.K,0)      SUPPLEMENT ADJUSTMENT FACTOR (1 OR 0)
A MSUPP.K=SUPADJ.K*SUPPL.K*F3.K     MONTHLY SUPPLEMENT
A SUPFAC1.K=TABLE(SF1TAB,MONTH.K,0,12,1) SUPPLEMENT FACTOR (BY MONTHS)
*              STOCKER SUPPLEMENT FACTOR TABLE (BY MONTHS
*                  1=COW SUPPLEMENT FED
*                  0=NO SUPPLEMENT FED
L STKTPM.K=STKTPM.J+DT*(STKSTON.JK) STOCKER TDN, PRIOR MONTH
R STKSTON.KL=MSTKSUP.K*MTONCLF.K    MONTHLY STOCKER SUPPLEMENT
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N STKTPM=0
A CSTKSUP.K=STKTPM.K+MSTKSUP.K        CUMULATIVE STOCKER SUPPLEMENT (LBS TON)
A MSTKSUP.K=CLIP(SUPFAC1.K,0,F_AG.K,TIME.K)*F4.K*F1.K MONTHLY STOCKER SUPPL
PRINT 1)MONTH(0,0)
PRINT 2)COWWT(0,1),COWFQI(0,1),MY(0,2)
PRINT 3)TONMLKP(0,2),TONCWML(0,2),TONCWGL(0,2)
PRINT 4)CLFADG(0,2),CALFFQI(0,1),AFCALF(0,1)
PRINT 5)CALFWGT(0,1),TONCLML(0,2),TONCLGL(0,2)
PRINT 6)MTONCOW,MTONCLF,CUMLTON(0,0)
PRINT 7)NEBP(0,4),SPLCST(0,2),CMC(0,2)
PRINT 8)NETTON(0,1),AVPTON(0,1),SUPPL(0,1)
PRINT 9)AVAUM(0,2),PTONC(0,1),PTONCST(0,2)
PRINT 10)CSUPTON(0,0),CPASTON(0,0),CSTKSUP(0,0)
PRINT 11)CFC(0,2),CFMC(0,2),CPPG(0,3)
PRINT 12)CUMCOM,CUMCOST,CALFMC(0,2)
PRINT 13)CEBP(0,4)CCFMC(0,2)
PRINT 14)CLFPRC(0,3),CLFVAL,PROFIT
*
*                   *-----------------------------------------*
*                   *   DEFINITION OF CERTAIN NMEMONICS USED  *
*                   *               IN PRINTOUT               *
*                   *-----------------------------------------*
*
NOTE 1 000 COW-CALF PROFITABILITY AND EFFICIENCY SIMULATOR
NOTE + 000
NOTE - 000 PRODUCTION PARAMETERS AND NUTRUIENT CONSUMPTION
* TIME1  INITIAL OCT-YR1 NOV-YR1 DEC-YR1 JAN-YR1 FEB-YR1 MAR-YR1 MAY-YR1 JUN-YR1
* TIME2  JUL-YR1 AUG-YR1 AUG-YR1 SEP-YR1 OCT-YR2 NOV-YR2 DEC-YR2 JAN-YR2 FEB-YR2
* TIME3  MAR-YR2
NOTE - 001 FOR COW
NOTE + 001
* COWWT    0---  WEIGHT (LBS)
* MY             MILK YIELD (LBS/DAY)
* COWFQI         FEED QUALITY INDEX (1-10)
* TONCWML        DAILY TON FOR: MAINTENANCE (LBS/DAY)
* TONCWGL                       GAIN (LBS/DAY)
* TONMLKP                       MILK PROD (LBS/DAY)
* MTONCOW        TON CONSUMED BY COW  DURING MONTH (LBS)
NOTE - 001 FOR CALF
NOTE + 001
* CALFWGT 0---   WEIGHT (LBS)
* CLFADG         GAIN (LBS/DAY)
* AFCALF         ACTIVITY FACTOR
* CALFFQI        FEED QUALITY INDEX (1-10)
* TONCLML        DAILY TON FOR: MAINTENANCE (LBS/DAY)
* TONCLGL                       GAIN (LBS/DAY)
* MTONCLF        TON CONSUMED BY CALF DURING MONTH (LBS)
NOTE - 001 FOR COW-CALF PAIR
NOTE + 001
* NETTON   0---  NET COW-CALF TON FOR MONTH (LBS)
* CUMLTON        TOTAL TON CONSUMED TO DATE (LBS)
* NEBP           CALF WEIGHT / TOTAL TON
NOTE - 000
NOTE - 000 DETERMINATION OF COSTS AND RETURNS
* TIME1  INITIAL OCT-YR1 NOV-YR1 DEC-YR1 JAN-YR1 FEB-YR1 MAR-YR1 MAY-YR1 JUN-YR1
* TIME2  JUL-YR1 AUG-YR1 AUG-YR1 SEP-YR1 OCT-YR2 NOV-YR2 DEC-YR2 JAN-YR2 FEB-YR2
* TIME3  MAR-YR2
NOTE - 001 COW-CALF OPERATION CONSUMPTION AND COSTS
NOTE + 001
* AVAUM    0---  AU MONTHS AVAILABLE GRAZING
* AVPTON         PASTURE TON AVAILABLE (LBS)
* NETTON         NET TON REQUIRED (LBS)
* PTONC          PASTURE TON CONSUMED (LBS)
* SUPPL          SUPPLEMENT NECESSARY (LBS TON)
* PTONCST 0      PASTURE COSTS CHARGED ($)
* SPLCST         SUPPLEMENT COSTS ($)
* CMC            OTHER COSTS ($)
* CCFMC          TOTAL COSTS ($)
NOTE - 001 CALF FEEDING OPERATION COSTS ($)
NOTE + 001
* CFC      0---  CALF FEED COSTS
* CALFMC         OTHER COSTS
* CFMC           TOTAL COSTS
* CPPG           COST/LB GAIN
NOTE - 001 TOTAL COSTS AND RETURNS ($)
* CLFPRC   0     CALF PRICE ($/LB)
* CLFVAL         VALUE OF CALF ($/ANIMAL)
* CEBP           COST/LB BEEF PRODUCED
* PROFIT         NET RETURNS TO DATE
SPEC DT=1/LENGTH=18/PRTPER=1/PLTPER=1
RUN ARL AVERAGE
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TIME	MONTH	COMWT COMFQI BY	TONMLBP TDNCMML TONCVGL	CLFADG CALFEQI AFCALF	CALFWGT TDNCLML TDNCLGL	MTDNCOW MTDNCLF CUMLTDN	NEBP SPLCST CMC	NETTDN AVPTDN SUPPL	AVAUM PTDNC PTDNCST	CSUPTDN CPASTDN CSTKSUP	CFC CFMC CPPG	CUMCPM CUMCOST CALFMC	CEBP CCFMC	CLFPRC CLFVAL PROFIT
E+00	E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00 E+00	E+00 E+00	E+00 E+00 E+00
.0	0.	.0 .0 .00	.00 .00 .00	.00 .0 .0	.0 .00 .00	.00 .00 0.	.0100 .00 .00	.0 .0 .0	.00 .0 .00	0. 0. 0.	.00 .00 .000	.00 .00 .00	.0000 .00	.500 .00 .00
1.	10.	1123.6 3.5 .00	.00 11.60 .67	.00 .0 .0	.0 .00 .00	373.37 .00 373.	.0000 2.39 1.72	373.4 312.0 61.4	.40 312.0 3.12	61. 312. 0.	.00 .00 .000	.00 7.23 .00	.0000 7.23	.500 .00 -7.23
2.	11.	1147.9 3.0 .00	.00 11.98 .72	.00 .0 .0	.0 .00 .00	386.57 .00 760.	.0000 15.08 1.72	386.6 .0 386.6	.00 .0 .00	448. 312. 0.	.00 .00 .000	7.23 24.02 .00	.0000 16.79	.500 .00 -24.02
3.	12.	1161.7 5.0 .00	.00 11.30 .59	.00 .0 .0	65.0 .00 .00	361.74 .00 1122.	.0000 14.11 1.72	361.7 .0 361.7	.00 .0 .00	810. 312. 0.	.00 .00 .000	24.02 39.85 .00	.0000 15.83	.500 32.50 -7.35
4.	1.	1059.2 5.0 12.00	3.69 10.55 .55	1.89 10.0 1.4	122.9 1.81 1.30	455.95 94.74 1616.	.0760 19.26 1.72	493.7 .0 493.7	.00 .0 .00	1303. 312. 0.	.00 .00 .000	39.85 60.82 .00	.4955 20.97	.500 61.38 .56
5.	2.	1009.1 5.0 11.64	3.78 10.17 .53	1.89 10.0 1.4	180.3 2.42 1.73	440.36 126.41 2127.	.0848 1.70 1.72	511.5 468.0 43.5	.60 468.0 4.68	1347. 780. 0.	.00 .00 .000	60.82 68.92 .00	.3822 8.10	.500 90.16 21.24
6.	3.	1022.6 7.0 11.04	3.32 9.68 .44	1.89 10.0 1.4	237.9 2.98 2.13	408.93 155.60 2639.	.0901 .00 1.72	512.1 702.0 -189.9	.90 512.1 5.12	1347. 1292. 0.	.00 .00 .000	68.92 75.76 .00	.3185 6.84	.500 118.93 43.18
7.	4.	1036.3 7.0 10.68	3.03 9.77 .45	1.89 10.0 1.4	295.4 3.51 2.51	403.20 183.05 3178.	.0930 .00 1.72	538.4 780.0 -241.6	1.00 538.4 5.38	1347. 1831. 0.	.00 .00 .000	75.76 82.86 .00	.2805 7.10	.500 147.71 64.85
8.	5.	1049.9 7.0 9.36	2.82 9.87 .45	1.89 10.0 1.4	353.0 4.01 2.87	399.68 209.20 3742.	.0943 .00 1.72	564.5 858.0 -293.5	1.10 564.5 5.64	1347. 2395. 0.	.00 .00 .000	82.86 90.22 .00	.2556 7.36	.500 176.49 86.27
9.	6.	1063.6 5.0 8.75	2.84 10.58 .55	1.89 10.0 1.4	410.5 4.49 3.21	425.04 234.29 4360.	.0942 .00 1.72	617.8 936.0 -318.2	1.20 617.8 6.18	1347. 3013. 0.	.00 .00 .000	90.22 98.12 .00	.2390 7.90	.500 205.27 107.15
10.	7.	1077.9 5.9 8.28	2.69 10.68 .56	1.89 10.0 1.4	468.1 4.95 3.55	423.58 258.52 5003.	.0936 .00 1.72	642.8 936.0 -293.2	1.20 642.8 6.43	1347. 3656. 0.	.00 .00 .000	98.12 106.26 .00	.2270 8.15	.500 234.05 127.78
11.	8.	1102.1 4.9 7.60	2.64 11.25 .62	1.89 10.0 1.4	525.6 5.40 3.87	441.37 282.01 5689.	.0924 .00 1.72	686.4 780.0 -93.6	1.00 686.4 6.86	1347. 4342. 0.	.00 .00 .000	106.26 114.84 .00	.2185 8.58	.500 262.82 147.98

TIME	MONTH	COWWT / COWFDI / MY	TDNMLKP / TDNC*ML / TDNC*GL	CLFADG / CALFFDI / AFCALF	CALFWGT / TDNCLML / TDNCLGL	MTDNCOW / MTDNCLF / CUMLTDN	NEBP / SPLCST / CMC	NETTDN / AVPTDN / SUPPL	AVALUM / PTDNC / PTDNCST	CSUPTDN / CPASTDN / CSTKSUP	CFC / CFMC / CPPG	CUMCPM / CUMCOST / CALFMC	CEBP / CCFMC	CLFPRC / CLFVAL / PROFIT
12.	9.	1126.8	2.49	1.00	556.1	449.86	.0877	649.1	.80	1372.	.00	114.84	.2226	.500
		3.5	11.63	10.0	5.64	233.39	.98	624.0	624.0	4966.	.00	123.78	8.94	278.06
		7.20	.67	1.4	2.04	6338.	1.72	25.1	6.24	0.	.000	.00		154.29
13.	10.	.0	.00	1.50	601.8	.06	.0913	.0	.40	1372.	17.52	123.78	.2362	.500
		3.5	.00	9.0	4.79	253.88	.00	312.0	.0	0.	18.40	142.18	.00	300.91
		.00	.00	1.1	3.55	6592.	.00	.0	.00	0.	.403	.88		158.73
14.	11.	.0	.00	2.07	664.9	.06	.0961	.0	.00	1372.	22.27	142.18	.2487	.500
		3.0	.00	9.0	5.16	322.71	.00	.0	.0	0.	23.15	165.32	.00	332.43
		.00	.00	1.1	5.44	6915.	.00	.0	.00	0.	.367	.88		167.10
15.	12.	.0	.00	2.07	727.9	.06	.1003	.0	.00	1372.	23.83	165.32	.2611	.500
		5.0	.00	9.0	5.53	345.39	.00	.0	.0	0.	24.71	190.04	.00	363.94
		.00	.00	1.1	5.83	7260.	.00	.0	.00	0.	.392	.88		173.91
16.	1.	.0	.00	2.07	790.9	.06	.1037	.0	.00	1372.	25.36	190.04	.2735	.500
		5.0	.00	9.0	5.88	367.59	.00	.0	.0	0.	26.24	216.28	.00	395.46
		.00	.00	1.1	6.20	7628.	.00	.0	.00	0.	.416	.88		179.18
17.	2.	.0	.00	2.07	853.9	.06	.1065	.0	.60	1372.	26.86	216.28	.2858	.500
		5.0	.00	9.0	6.23	389.35	.00	468.0	.0	0.	27.74	244.02	.00	426.97
		.00	.00	1.1	6.57	8017.	.00	.0	.00	0.	.440	.88		182.95
18.	3.	.0	.00	2.07	917.0	.05	.1088	.0	.90	1372.	28.34	244.02	.2980	.500
		7.0	.00	9.0	6.57	410.71	.00	702.0	.0	0.	29.22	273.24	.00	458.49
		.00	.00	1.1	6.93	8428.	.00	.0	.00	0.	.464	.88		185.24

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*
*                  **************** MODEL II *****************
*                  *                                         *
*                  *        HERD EFFICIENCY ESTIMATOR        *
*                  *                                         *
*                  *******************************************
*
*
*                  *-----------------------------------------*
*                  *  THE FOLLOWING ARE CONSTANTS AND TABLES *
*                  *         USED IN THE INITIAL RUN         *
*                  *-----------------------------------------*
*
* ACCW=                                AVE. CULL COW WEIGHT (LBS)
T ACCW=1/1/1/1/1/1/1/1/1047
X /1/1/1/1/1/1/1/956
X /1/1/1/1/1/1/1/1097
X /1/1/1/1/1/1/1/1041
X /1/1/1/1/1/1/1/1029
X /1/1/1/1/1/1/1/1019
X /1/1/1/1/1/1/1/1045
X /1/1/1/1/1/1/1/1088
X /1/1/1/1/1/1/1/1100
* ADMY=                                AVE. DAILY MILK YIELD (LBS/DAY)
T ADMY=1/1/1/1/1/1/1/1/12
X /1/1/1/1/1/1/1/11
X /1/1/1/1/1/1/1/12
X /1/1/1/1/1/1/1/11.5
X /1/1/1/1/1/1/1/11.5
X /1/1/1/1/1/1/1/12
X /1/1/1/1/1/1/1/12
X /1/1/1/1/1/1/1/13
X /1/1/1/1/1/1/1/12.5
* BW=                                  CALF BIRTH WEIGHT (LBS)
T BW=1/1/1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
X /1/1/1/1/1/1/65
* PREG=                                PREGNANCY %
T PREG=89.9/89.9/89.9/89.9/89.9/89.9/89.9/89.9
X /88.5/88.5/88.5/88.5/88.5/88.5/88.5
X /90.5/90.5/90.5/90.5/90.5/90.5/90.5
X /92.5/92.5/92.5/92.5/92.5/92.5/92.5
X /93.8/93.8/93.8/93.8/93.8/93.8/93.8
X /86.6/86.6/86.6/86.6/86.6/86.6/86.6
X /93.4/93.4/93.4/93.4/93.4/93.4/93.4
X /83.0/83.0/83.0/83.0/83.0/83.0/83.0
X /90.1/90.1/90.1/90.1/90.1/90.1/90.1
* SUR=                                 SURVIVAL % (CALVES)
T SUR=92.7/92.7/92.7/92.7/92.7/92.7/92.7/92.7
X /95.5/95.5/95.5/95.5/95.5/95.5/95.5
X /90.4/90.4/90.4/90.4/90.4/90.4/90.4
X /95.5/95.5/95.5/95.5/95.5/95.5/95.5
X /91.5/91.5/91.5/91.5/91.5/91.5/91.5
X /94.5/94.5/94.5/94.5/94.5/94.5/94.5
X /88.7/88.7/88.7/88.7/88.7/88.7/88.7
X /96.3/96.3/96.3/96.3/96.3/96.3/96.3
X /89.4/89.4/89.4/89.4/89.4/89.4/89.4
* ADG1=                                ADG. PERIOD 1(LBS/DAY)
T ADG1=1/1/1/1/1/1/1/1/1.89
X /1/1/1/1/1/1/1/1.67
X /1/1/1/1/1/1/1/1.96
X /1/1/1/1/1/1/1/1.82
X /1/1/1/1/1/1/1/1.88
X /1/1/1/1/1/1/1/1.94
X /1/1/1/1/1/1/1/1.94
X /1/1/1/1/1/1/1/2.10
X /1/1/1/1/1/1/1/1.99
* ADG2=                                ADG. PERIOD 2 (LBS/DAY)
T ADG2=1/1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
X /1/1/1/1/1/1/1/1.00
* ADG3=                                ADG. PERIOD 3 (LBS/DAY)
T ADG3=1/1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
X /1/1/1/1/1/1/1/1.50
* ADG4=                                ADG. PERIOD 4 (LBS/DAY)
T ADG4=1/1/1/1/1/1/1/1/2.07
X /1/1/1/1/1/1/1/1.85
X /1/1/1/1/1/1/1/2.09
X /1/1/1/1/1/1/1/2.08
X /1/1/1/1/1/1/1/2.13
X /1/1/1/1/1/1/1/1.98
X /1/1/1/1/1/1/1/2.22
X /1/1/1/1/1/1/1/2.07
X /1/1/1/1/1/1/1/2.14
* AWW=                                 AVE. WEANING WEIGHT (LBS)
T AWW=1/1/1/1/1/1/1/1/556
X /1/1/1/1/1/1/1/503
X /1/1/1/1/1/1/1/573
X /1/1/1/1/1/1/1/539
X /1/1/1/1/1/1/1/554
X /1/1/1/1/1/1/1/568
X /1/1/1/1/1/1/1/568
X /1/1/1/1/1/1/1/607
X /1/1/1/1/1/1/1/581
* COWTDN=                               COW TDN (LBS/ANIMAL)
T COWTDN=1/1/1/1/1/1/1/1/6338
X /1/1/1/1/1/1/1/5935
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X  /1/1/1/1/1/1/6548
X  /1/1/1/1/1/1/6238
X  /1/1/1/1/1/1/6259
X  /1/1/1/1/1/1/6303
X  /1/1/1/1/1/1/6379
X  /1/1/1/1/1/1/6693
X  /1/1/1/1/1/1/6603
*  CMC=                                   COW MAINTENANCE COSTS ($/YR)
T  CMC=1/1/1/1/1/1/1/123.78
X  /1/1/1/1/1/1/113.70
X  /1/1/1/1/1/1/128.45
X  /1/1/1/1/1/1/121.95
X  /1/1/1/1/1/1/121.94
X  /1/1/1/1/1/1/122.45
X  /1/1/1/1/1/1/124.36
X  /1/1/1/1/1/1/130.64
X  /1/1/1/1/1/1/129.49
*  ASTW=                                  AVE. STOCKER WEIGHT (LBS)
T  ASTW=1/1/1/1/1/1/1/556
X  /1/1/1/1/1/1/503
X  /1/1/1/1/1/1/573
X  /1/1/1/1/1/1/539
X  /1/1/1/1/1/1/554
X  /1/1/1/1/1/1/568
X  /1/1/1/1/1/1/568
X  /1/1/1/1/1/1/507
X  /1/1/1/1/1/1/561
*  STKTDN=                                TDN THRU STOCKER PHASE (LBS/ANIMAL)
T  STKTDN=1/1/1/1/1/1/1/6338
X  /1/1/1/1/1/1/5835
X  /1/1/1/1/1/1/6548
X  /1/1/1/1/1/1/6238
X  /1/1/1/1/1/1/6259
X  /1/1/1/1/1/1/6303
X  /1/1/1/1/1/1/6379
X  /1/1/1/1/1/1/6693
X  /1/1/1/1/1/1/6603
*  CSTC=                                  CUMULATIVE STOCKER COST ($)
T  CSTC=1/1/1/1/1/1/1/123.78
X  /1/1/1/1/1/1/113.70
X  /1/1/1/1/1/1/128.45
X  /1/1/1/1/1/1/121.95
X  /1/1/1/1/1/1/121.94
X  /1/1/1/1/1/1/122.45
X  /1/1/1/1/1/1/124.36
X  /1/1/1/1/1/1/130.64
X  /1/1/1/1/1/1/129.49
*  ASW=                                   AVE. SLAUGHTER WEIGHT (LBS)
T  ASW=1/1/1/1/1/1/1/917
X  /1/1/1/1/1/1/930
X  /1/1/1/1/1/1/937
X  /1/1/1/1/1/1/902
X  /1/1/1/1/1/1/924
X  /1/1/1/1/1/1/916
X  /1/1/1/1/1/1/952
X  /1/1/1/1/1/1/968
X  /1/1/1/1/1/1/952
*  FDLTDN=                                TDN THRU FEEDLOT PHASE (LBS/ANIMAL)
T  FDLTDN=1/1/1/1/1/1/1/8428
X  /1/1/1/1/1/1/7676
X  /1/1/1/1/1/1/8687
X  /1/1/1/1/1/1/8299
X  /1/1/1/1/1/1/8363
X  /1/1/1/1/1/1/8359
X  /1/1/1/1/1/1/8596
X  /1/1/1/1/1/1/8888
X  /1/1/1/1/1/1/8791
*  CFLC=                                  CUMULATIVE COSTS THRU FEEDLOT ($)
T  CFLC=1/1/1/1/1/1/1/273.24
X  /1/1/1/1/1/1/246.00
X  /1/1/1/1/1/1/281.25
X  /1/1/1/1/1/1/269.44
X  /1/1/1/1/1/1/273.40
X  /1/1/1/1/1/1/269.54
X  /1/1/1/1/1/1/282.55
X  /1/1/1/1/1/1/287.31
X  /1/1/1/1/1/1/285.06
*  CSUPTAB=                               COW SUPPLEMENT TABLE  (LBS TDN/YR)
T  CSUPTAB=1/1/1/1/1/1/1/1372
X  /1/1/1/1/1/1/1198
X  /1/1/1/1/1/1/1461
X  /1/1/1/1/1/1/1244
X  /1/1/1/1/1/1/1336
X  /1/1/1/1/1/1/1338
X  /1/1/1/1/1/1/1378
X  /1/1/1/1/1/1/1486
X  /1/1/1/1/1/1/1477
*  SSUPTAB=                               STOCKER SUPPLEMENT TABLE (LBS TDN/YR)
T  SSUPTAB=1/1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
X  /1/1/1/1/1/1/0
*  FCP=                                   FEEDER CALF PRICE ($/LB)
T  FCP=1/1/1/1/1/1/1/.492/
X  1/1/1/1/1/1/.4946/
X  1/1/1/1/1/1/.4933/
X  1/1/1/1/1/1/.4933/
X  1/1/1/1/1/1/.4933/
X  1/1/1/1/1/1/.4946/
X  1/1/1/1/1/1/.4867/
X  1/1/1/1/1/1/.4946/
X  1/1/1/1/1/1/.484/
*  SCP=                                   SLAUGHTER CALF PRICE ($/LB)
T  SCP=1/1/1/1/1/1/1/.4953/
X  1/1/1/1/1/1/.4977/
X  1/1/1/1/1/1/.488/
X  1/1/1/1/1/1/.4936/
X  1/1/1/1/1/1/.4977/
X  1/1/1/1/1/1/.5026/
X  1/1/1/1/1/1/.5042/
X  1/1/1/1/1/1/.4872/
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* AWW=                                   AVERAGE WEANING WEIGHT (LBS)
* FCP=                                   FEEDER CALF PRICE ($/LB)
A HKF.K=CALFW.K-SKF.K-HK1.K              HEIFERS KEPT FOR FEEDING
A SKF.K=CALFW.K*0.5                      STEERS KEPT FOR FEEDING
A SALES1.K=VFC.K+VCC.K                   LIVESTOCK SALES, ALTERNATIVE 1
A VAREXP1.K=CPC.K                        VARIABLE EXPENSES, ALT 1
A COSTS1.K=VAREXP1.K+O_EXP1.K            PRODUCTION COSTS, ALT 1
A O_EXP1.K=OC                            OTHER EXPENSES, ALT. 1
A PROFIT1.K=SALES1.K-COSTS1.K            RETURNS ABOVE PRODUCTIONS COSTS, ALT 1
A PRPLB1.K=PROFIT1.K/(FC.K*W.K+CCS.K*AC.K)  PROFIT/LB BEEF SOLD, ALT 1
A COSTLB1.K=COSTS1.K/(FC.K*W.K+CCS.K*AC.K)  COST/LB BEEF SOLD, ALT 1
A CPPTON1.K=COSTS1.K/TON1.K              COST/LB TON, ALTERNATIVE 1
NOTE          STOCKER SALES (SELL CALVES AT STOCKER WEIGHTS)
L SC.K=SC.J+DT*(COF.JK-SCS.JK)           STOCKER OR SLAUGHTER CALVES/YEARLINGS
R COF.KL=FC.K-STDL.K                     CALVES ON FEED
R SCS.KL=SC.K                            SLAUGHTER YEARLINGS SOLD
* ASTW=                                  AVERAGE STOCKER WEIGHT (LBS)
A STDL.K=FC.K*PSTD*.01                   STOCKER DEATH LOSSES
* PSTD=                                  PCT STOCKERS DIED
A VST.K=SC.K*AS.K*T.K                    VALUE OF STOCKERS
A CFST.K=SC.K*(AS.K-W.K)*CGSTF.K         COST OF FEEDING STOCKERS
A CGSTF.K=(STC.K-COWMC.K)/(AS.K-W.K+.1) COST OF GAIN,STOCKER FEED
A SALES2.K=VST.K+VCC.K                   LIVESTOCK SALES, ALTERNATIVE 2
A VAREXP2.K=CPC.K+CFST.K                 VARIABLE EXPENSES, ALT 2
A COSTS2.K=VAREXP2.K+O_EXP2.K            PRODUCTION COSTS, ALT 2
A O_EXP2.K=OC                            OTHER EXPENSES, ALT. 2
A PROFIT2.K=SALES2.K-COSTS2.K            RETURNS ABOVE PRODUCTIONS COSTS, ALT 2
A COSTLB2.K=COSTS2.K/(SC.K*AS.K+CCS.K*AC.K) COST/LB BEEF SOLD, ALT 2
A PRPLB2.K=PROFIT2.K/(SC.K*AS.K+CCS.K*AC.K) PROFIT/LB BEEF SOLD, ALT 2
A CPPTON2.K=COSTS2.K/TON2.K              COST/LB TON, ALTERNATIVE 2
NOTE          SLAUGHTER SALES (FINISH STEERS AND HIEFERS TO SLAUGHTER WTS)
A VSC.K=SC.K*A.K*Y.K                     VALUE OF SLAUGHTER YEARLINGS
A CGSLF.K=(FLC.K-STC.K)/(A.K-AS.K+.1) COST OF GAIN, FEEDLOT
A CFSC.K=SC.K*((AS.K-W.K)*CGSTF.K+(A.K-AS.K)*CGSLF.K) COST OF FEEDING SC
A SALES3.K=VSC.K+VCC.K                   LIVESTOCK SALES, ALTERNATIVE 3
A VAREXP3.K=CPC.K+CFSC.K                 VARIABLE EXPENSES, ALT 3
A COSTS3.K=VAREXP3.K+O_EXP3.K            PRODUCTION COSTS, ALT 3
A O_EXP3.K=OC                            OTHER EXPENSES, ALT. 3
A PROFIT3.K=SALES3.K-COSTS3.K            RETURNS ABOVE PRODUCTIONS COSTS, ALT 3
A COSTLB3.K=COSTS3.K/(SC.K*A.K+CCS.K*AC.K)  COST/LB BEEF SOLD, ALT 3
A PRPLB3.K=PROFIT3.K/(SC.K*A.K+CCS.K*AC.K)  PROFIT/LB BEEF SOLD, ALT 3
A CPPTON3.K=COSTS3.K/TON3.K              COST/LB TON, ALTERNATIVE 3
A COWMC.K=C.K
A F_P.K=F.K
A ST_P.K=T.K
A SC_P.K=Y.K
A CC_W.K=AC.K
A F_W.K=W.K
A ST_W.K=AS.K
A SC_W.K=A.K
A CC_TON.K=COWT.K
NOTE
NOTE                              DETERMINATION OF ACREAGE REQUIREMENTS
NOTE
A PAST.K=COWT.K-CSUPT.K                  PASTURE TON
* CSUPTAB=                               COW SUPPLEMENT TON (FROM CSUPTON)
* SSUPTAB=                               STOCKER SUPPLEMENT TON (FROM CSTKSUP)
A PAS_AC.K=PSTON.K/TPAPAS                PASTURE ACREAGE
A SUP_AC1.K=SPTON1.K/TPASUP              SUPPLEMENT ACREAGE (E.G. SILAGE), #1
A SUP_AC2.K=SPTON2.K/TPASUP              SUPPLEMENT ACREAGE (E.G. SILAGE), #2
A STK_AC.K=((ST_TONF.K+BR.K*(BRT.K-SSUPT.K))/TPASTK)*STKFAC STOCKER AC
A ST_TONF.K=ST_TON.K-SSUPT.K*SC.K        STOCKER TON, FORAGE
A FDL_AC.K=(SC_TON.K+(BR.K*BRSTON)*(1-STKFAC))/TPAFDL FEEDLOT RATION AC
*               1=BRED REPLACEMENTS ON STOCKER FORAGE
*               0=BRED REPLACEMENTS FED FEEDLOT SUPPLEMENT ON COW PASTURES
A PSTON.K=(COWS.K-((12-MOCM)/12)*(CCS.K-CCSAC.K)-((12-MCLCM)/12)*CCSAC.K
X )*PAST.K+BRTPAS.K*(1-STKFAC)           PASTURE TON
A SPTON1.K=(COWS.K-((12-MOCM)/12)*(CCS.K-CCSAC.K)-((12-MCLCM)/12)*CCSAC.
X K)*CSUPT.K+(BR.K*SSUPT.K)*STKFAC+BRTSUP.K*(1-STKFAC) SUPPL TON, ALT. 1
A SPTON2.K=SPTON1.K+SSUPT.K*SC.K         SUPPLEMENT TON, ALT. 2
A BRTPAS.K=BR.K(PAST.K-(PAST.K/COWT.K)*(BRSTON/.8))*.8
*                                        BRED REPL TON FROM PASTURE
A BRTSUP.K=BR.K(CSUPT.K-(CSUPT.K/COWT.K)*(BRSTON/.8))*.8
*                                        BRED REPL TON FROM SUPPLEMENT
A BRSTAC1.K=(BR.K*(BRT.K-SSUPT.K)/TPASTK)*STKFAC  STOCKER AC USED BY BR
A TOT_AC1.K=PAS_AC.K+SUP_AC1.K+BRSTAC1.K TOTAL ACREAGE, ALT. 1
A TOT_AC2.K=PAS_AC.K+SUP_AC2.K+STK_AC.K TOTAL ACREAGE, ALT. 2
A TOT_AC3.K=PAS_AC.K+SUP_AC2.K+STK_AC.K TOTAL ACREAGE, ALT. 3
A TOTAC3.K=TOT_AC3.K+FDL_AC.K            TOTAL ACRES, ALT. 3 (GROW GRAIN)
A PPA1.K=PROFIT1.K/TOT_AC1.K             PROFIT PER ACRE, ALT. 1
A PPA2.K=PROFIT2.K/TOT_AC2.K             PROFIT PER ACRE, ALT. 2
A PPA3.K=PROFIT3.K/TOT_AC3.K             PROFIT PER ACRE, ALT. 3
A PPA3A.K=(PROFIT3.K+GRNPRFT.K)/TOTAC3.K  PROFIT/AC (GROW OWN GRAIN)
A GRNPRFT.K=FDL_AC.K*(GRNVAL-GRNCOST)*GRNYLD GRAIN PROFIT
A BPA1.K=(FC.K*W.K+CCS.K*AC.K)/TOT_AC1.K BEEF/ACRE, ALT. 1
A BPA2.K=(SC.K*AS.K+CCS.K*AC.K)/TOT_AC2.K BEEF/ACRE, ALT. 2
A BPA3.K=(SC.K*A.K+CCS.K*AC.K)/TOT_AC3.K BEEF/ACRE, ALT. 3
A BPA3A.K=(SC.K*A.K+CCS.K*AC.K)/TOTAC3.K BEEF/ACRE, ALT. 3 (GROW GRAIN)
A TONCK1.K=PSTON.K+SPTON1.K+(BR.K*BRSTON)*(1-STKFAC)+BR.K*(BRT.K-SSUPT.K
X )*STKFAC                               TON CHECK 1
A TONCK2.K=PSTON.K+(SPTON1.K+BR.K*BRSTON)*(1-STKFAC)+(SPTON2.K+STK_AC.K*
X TPASTK)*STKFAC                         TON CHECK 2
A TONCK3.K=PSTON.K+SPTON2.K+FDL_AC.K*TPAFDL+(STK_AC.K*TPASTK*STKFAC)
A ADG_1.K=TABHL(ADG1,TIME.K,0,63,1)   AVE DAILY GAIN, PERIOD 1
A ADG_2.K=TABHL(ADG2,TIME.K,0,63,1)   AVE DAILY GAIN, PERIOD 2
A ADG_3.K=TABHL(ADG3,TIME.K,0,63,1)   AVE DAILY GAIN, PERIOD 3
A ADG_4.K=TABHL(ADG4,TIME.K,0,63,1)   AVE DAILY GAIN, PERIOD 4
A ADG_5.K=TABHL(ADG5,TIME.K,0,63,1)   AVE DAILY GAIN, PERIOD 5
A ADG_6.K=TABHL(ADG6,TIME.K,0,63,1)   AVE DAILY GAIN, PERIOD 6
A BWT.K=TABHL(BW,TIME.K,0,63,1)       BIRTH WEIGHT
A F.K=TABHL(FCP,TIME.K,0,63,1)        FEEDER CALF PRICE $/LB)
A T.K=TABHL(STP,TIME.K,0,01,1)        STOCKER PRICE ($/LB)
A Y.K=TABHL(SCP,TIME.K,0,63,1)        SLAUGHTER PRICE ($/LB)
A PR.K=TABHL(PREG,TIME.K,0,63,1)      PREGNANCY RATE
A SR.K=TABHL(SUR,TIME.K,0,63,1)       SURVIVAL RATE OF CALVES
A C.K=TABHL(CMC,TIME.K,0,63,1)        COW MAINTENANCE COSTS ($/YR)
A AC.K=TABHL(ACCW,TIME.K,0,63,1)      AVE. CULL COW WEIGHT (LBS)
A W.K=TABHL(AWW,TIME.K,0,63,1)        AVE. WEANING WEIGHT (LBS)
A AS.K=TABHL(ASTW,TIME.K,0,63,1)      AVE. STOCKER WEIGHT (LBS)
A A.K=TABHL(ASW,TIME.K,0,63,1)        AVE. SLAUGHTER WEIGHT (LBS)
A COWT.K=TABHL(COWTON,TIME.K,0,63,1)  COW TON (LBS)
A STK_T.K=TABHL(STKTON,TIME.K,0,63,1)
A FDL_T.K=TABHL(FDLTON,TIME.K,0,63,1)
A FLC.K=TABHL(CFLC,TIME.K,0,63,1)     FEEDLOT COSTS
A STC.K=TABHL(CSTC,TIME.K,0,63,1)     STOCKER COSTS
A ADMY1.K=TABHL(ADMY,TIME.K,0,63,1)   AVE DAILY MILK YIEL
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A SSUPT.K=TABHL(SSUPTAB.TIME.K.0.63.1) STOCKER SUPPLEMENT TDN
A CSUPT.K=TABHL(CSUPTAB.TIME.K.0.63.1) COW SUPPLEMENT TDN
A RCF.K=(COWMC.K+HSC)*(1-STKFAC)    REPLACEMENT HEIFER COST. FEEDLOT
A BRTF.K=(COWT.K*R.R)*(1-STKFAC)    BRED REPLACEMENT TDN. FEEDLOT
A RCP.K=(STC.K-COWMC.K-CALFMC*12+RHLE)*STKFAC REPLACEMENT COSTS. PASTURE
A BRTP.K=(STK_T.K-COWT.K)*STKFAC    BRED REPLACEMENT TDN. PASTURE
A RC.K=RCF.K+RCP.K                  REPLACEMENT COSTS
A BRT.K=BRTF.K+BRTP.K               BRED REPALCEMENT TDN
PRINT 1)COWS(0.0).HK1(0.0).CCS(0.0).FC(0.0).SC(0.0)
PRINT 2)CALFW(0.0).COWMC(0.2).RC(0.2).CGSTF(0.4).CGSLF(0.4)
PRINT 3)RPA1(0.1).RPA2(0.1).RPA3A(0.1)
PRINT 4)F_P(0.3).ST_P(0.3).SC_P(0.3).ADG_1(0.2).ADMY1(0.0)
PRINT 5)SALES1.SALES2.SALES3.ADG_2(0.2).PR(0.1)
PRINT 6)COSTS1.COSTS2.COSTS3.ADG_3(0.2).SR(0.1)
PRINT 7)PROFIT1.PROFIT2.PROFIT3.ADG_4(0.2).WR(0.1)
PRINT 8)TDNPLB1(0.2).TDNPLB2(0.2).TDNPLB3(0.2).ADG_5(0.2).CW_TDN(0.0)
PRINT 09)TDN1.TDN2.TDN3.ADG_5(0.2).STKT(0.0)
PRINT 10)COSTLB1(0.4).COSTLB2(0.4).COSTLB3(0.4).BWT(0.0).FDLT(0.0)
PRINT 11)CPPTDN1(0.4).CPPTDN2(0.4).CPPTDN3(0.4).W_W(0.0).PSTDN(3.1)
PRINT 12)PPPLB1(0.4).PPPLB2(0.4).PPPLB3(0.4).ST_W(0.0).SPTDN1(3.1)
PRINT 13)TOT_AC1(0.1).TOT_AC2(0.1).TOTAC3(0.1).S_W(0.0).SPTDN2(3.1)
PRINT 14)PPA1(0.2).PPA2(0.2).PPA3A(0.2).CC_W(0.0).BRT(0.1)
PRINT 1)PAST.CSUPT
PRINT 2)SSUPT.RR.RPA3(0.1)
PRINT 3)PAS_AC(0.1).SUP_AC1(0.1).SUP_AC2(0.1).STK_AC(0.1).FDL_AC(0.1)
PRINT 4)RRSTAC1
PRINT 5)BRTPAS(3.1).BRTSUP(3.1)
PRINT 9)TDNCK1.TDNCK2.TDNCK3.
PRINT 14)TOT_AC3(0.1).PPA3(0.2)
*
*                   *----------------------------------------*
*                   *  DEFINITION OF CERTAIN NMEMONICS USED   *
*                   *               IN PRINTOUT               *
*                   *----------------------------------------*
*
NOTE 1 000 ASSUMED BIOLOGICAL FACTORS
NOTE + 000 ------------------------------------
* TIME1            LOW 1   LOW 2   LOW 3   LOW 4   MOD 1   MOD 2   MOD 3   HI 1
* TIME2     HI 2    HI 3   V HI 1  V HI 2  V HI 3
NOTE - 000 COW CHARACTERISTICS (LBS)
* CC_W      0      MATURE COW WEIGHT
* ADMY1            AVE. DAILY MILK YIELD. 1ST MO.
NOTE - 000 CALF WEIGHTS AND GAINS (LBS)
* BWT       0      BIRTH WEIGHT
NOTE   001 AVE. DAILY GAINS:
* ADG_1                BIRTH TO WEANING
* ADG_2                9TH MO.
* ADG_3                10TH MONTH
* ADG_4                11TH THRU 15TH MONTH
NOTE - 000 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
NOTE - 000 CALCULATED BIOLOGICAL FACTORS
NOTE + 000 ---------------------------------
NOTE - 000 CALF WEIGHTS
* W_W       0      AT WEANING ( 8 MO.)
* ST_W             AT SLAUGHTER (16 MO.)
NOTE - 000 TDN CONSUMPTION (LBS/ANIMAL)
* CW_TDN    0      TO WEANING (COW-CALF. 12 MO.)
* FDLT             IN FEEDLOT (CALF. 8 MO.)
NOTE - 000 COSTS AND PRICES
NOTE - 000 CALCULATED ECONOMIC FACTORS
NOTE + 000 ---------------------------------
* COWMC     0      COW MAINTENANCE ($/YR/COW)
* RC               REPLACEMENT HEIFER MAINTENANCE ($/YR)
NOTE 0 001 GAIN COSTS($/LB):
* CGSLF                IN FEEDLOT
NOTE 0 001 CALF VALUE ($/LB):
* F_P                  AT WEANING
* SC_P                 AT SLAUGHTER
NOTE 1 000 COSTS AND RETURNS FOR BEEF OPERATION (1000 COWS)
NOTE + 000 ------------------------------------------------
* TIME1            LOW 1   LOW 2   LOW 3   LOW 4   MOD 1   MOD 2   MOD 3   HI 1
* TIME2     HI 2    HI 3   V HI 1  V HI 2  V HI 3
NOTE - 000 HERD COMPOSITION
* COWS      0      COWS
* PR        0      % PREGNANCY
* SR               % CALF SURVIVAL
* WR               % COWS WEANING CALVES
* CALFW     0      CALVES WEANED
* HK1                  REPLACEMENT HEIFERS KEPT
* FC                   CALVES TO FEED
* SC               SLAUGHTER YEARLINGS
NOTE - 000 TOTAL TDN CONSUMED BY HERD (LBS)
* TDN1      0      TO WEANING
* TDN3             TO SLAUGHTER
NOTE - 000 TDN CONSUMED PER POUND BEEF SOLD
* TDNPLB1 0      AT WEANING
* TDNPLB3        AT SLAUGHTER
NOTE - 000 BEEF PRODUCED PER ACRE
* RPA1      0      TO WEANING
* RPA3A            TO SLAUGHTER
NOTE - 000 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
NOTE - 000 INCOME. COSTS. AND RETURNS AT WEANING ($)
* SALES1    0      TOTAL SALES
* COSTS1           PRODUCTION COSTS
* PROFIT1          NET RETURNS
* COSTLB1   0      COST/LB BEEF PRODUCED
* CPPTDN1          COST/LB TDN CONSUMED
* PPPLB1           NET RETURNS / LB BEEF PRODUCED
* PPA1             NET RETURNS / ACRE
NOTE - 000 INCOME. COSTS. AND RETURNS AT SLAUGHTER ($)
* SALES3    0      TOTAL SALES
* COSTS3           PRODUCTION COSTS
* PROFIT3          NET RETURNS
* COSTLB3   0      COST/LB BEEF PRODUCED
* CPPTDN3          COST/LB TDN CONSUMED
* PPPLB3           NET RETURNS / LB BEEF PRODUCED
* PPA3A            NET RETURNS / ACRE
SPEC DT=1/LENGTH=63/PRTPER=7/PLTPER=1
RUN RPU
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ANIMALS NOT USED

HKF NOT USED

AU NOT USED
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TIME	COWS HKT CCS FC SC	CALFW COWMC RC CGSIF CGSLF	HPA1 HPA2 HPA3A PAS_AC SUP_AC1	F_P ST_P SC_P ADG_1 ADMY1	SALES1 SALES2 SALES3 ADG_2 PR	COSTS1 COSTS2 COSTS3 ADG_3 SR	PROFIT1 PROFIT2 PROFIT3 ADG_4 WR	TDNPLB1 TDNPLB2 TDNPLB3 ADG_5 CW_TDN	TDN1 TDN2 TDN3 ADG_6 STRT	COSTLB1 COSTLB2 COSTLB3 BWT FDLT	CPPTDN1 CPPTDN2 CPPTDN3 W_W PSTDN	PRPLB1 PRPLB2 PRPLB3 ST_W SPTDN1	TOT_AC1 TOT_AC2 TOTAC3 S_W SPTDN2	PPA1 PPA2 PPA3A CC_W BRT
	PAST CSUPT	SSUPT HR HPA3	SUP_AC2 STR_AC FDL_AC	HRSTAC1	HRTPAS HRTSUP				TDNCK1 TDNCK2 TDNCK3					TOT_AC3 PPA3
E+00	E+00	E+03	E+00	E+00	E+03	E+03	E+03	E+00	E+03	E+00	E+00	E+00	E+00	E+00
	E+00	E+00	E+00	E+00	E+03	E+03	E+03	E+00	E+03	E+00	E+00	E+00	E+00	E+00
	E+00	E+00	E+00	E+00	E+03	E+03	E+03	E+00	E+03	E+00	E+00	E+00	E+00	E+00
	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00
	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+00	E+03	E+03	E+03	E+00
	E+00	E+00	E+00	E+00	E+03				E+03					E+00
	E+00	E+00	E+00		E+03				E+03					E+00
		E+00	E+00						E+03					
.0	1000.	833.	-28.2	1.000	.67	13.38	-12.72	1.22	1.0	16.28X	13.30X	-15.47X	-29.2	435.85
	242.	1.00	-23.5	.500	.30	13.38	-13.08	1.47	1.0	19.55X	13.30X	-19.11X	-29.1	449.49
	231.	50.01	21.6	1.000	.53	13.38	-12.85	1.47	1.0	19.55X	13.30X	-18.78X	31.7	-290.92
	591.	.0000	.0	1.00	1.00	1.00	1.00	.00	.00	1.	1.	1.	1.	1.
	454.	.0000	-29.2	1.	89.9	92.7	83.3	1.	0.	0.	.0	-175.0	-174.6	.8
	.0	1.0000	-29.1	0.	.0				1.0					-29.1
	1.0	251.50	.0		-175.9				1.0					441.70
		-23.5	60.7						1.5					
7.	1000.	833.	357.1	.492	237.10	142.37	94.73	11.49	6396.2	.2558	.0223	.1702	1558.6	60.78
	240.	123.73	355.0	.500	238.09	142.37	95.72	11.56	6396.2	.2573	.0223	.1730	1558.6	61.41
	217.	172.79	375.3	.495	341.55	230.11	111.44	9.96	7623.5	.3007	.0302	.1456	2039.3	68.79
BRU	593.	.0000	1333.8	1.89	1.00	1.50	2.07	.00	.00	65.	556.	556.	917.	1047.
Ave.	587.	.4139	224.8	12.	89.9	92.7	83.3	6338.	0.	2090.	4881.8	1348.7	1348.7	5070.4
	4966.0	.0000	224.8	0.	810.3				6396.2					1558.6
	1372.0	236.63	.0		223.9				6396.2					71.50
		491.0	480.6						7623.5					
14.	1000.	845.	355.6	.495	218.10	129.55	88.55	11.50	5820.7	.2560	.0223	.1750	1423.4	62.21
	228.	113.70	353.4	.500	218.23	129.55	88.67	11.57	5820.7	.2575	.0223	.1763	1423.4	62.29
	205.	162.71	376.7	.493	316.92	210.33	106.59	9.88	6945.1	.2993	.0303	.1517	1865.7	71.35
A/A	617.	.0000	1229.7	1.67	1.00	1.50	1.85	.00	.00	65.	503.	503.	830.	956.
	611.	.4045	193.8	11.	88.5	95.5	84.5	5835.	0.	1841.	4500.5	1162.7	1162.7	4668.0
	4637.0	.0000	193.8	0.	709.0				5820.7					1423.4
	1198.0	224.83	.0		183.2				5820.7					74.88
		493.7	442.3						6945.1					
21.	1000.	818.	356.3	.493	242.91	149.53	93.38	11.56	6663.5	.2593	.0224	.1619	1618.2	57.71
	256.	128.45	354.3	.500	243.46	149.53	93.93	11.62	6663.5	.2608	.0224	.1638	1618.2	58.05
	232.	177.46	371.3	.488	338.54	234.59	103.95	10.12	7854.4	.3023	.0299	.1339	2090.0	63.28
	562.	.0000	1377.0	1.96	1.00	1.50	2.09	.00	.00	65.	573.	573.	937.	1097.
H/H	557.	.4197	241.2	12.	90.5	90.4	81.8	6548.	0.	2139.	5039.7	1447.4	1447.4	5238.4
	5087.0	.0000	241.2	0.	888.1				6663.5					1618.2
	1463.0	251.88	.0		255.1				6663.5					64.24
		479.6	471.8						7854.4					
28.	1000.	883.	356.3	.493	241.74	136.28	105.46	11.45	6270.3	.2489	.0217	.1926	1536.6	68.64
	189.	121.95	353.9	.500	242.38	136.28	106.10	11.53	6270.3	.2506	.0217	.1951	1536.6	69.05
	167.	170.96	383.1	.494	363.10	237.57	125.53	9.69	7686.2	.2995	.0309	.1583	2070.2	76.10
	594.	.0000	1316.1	1.82	1.00	1.50	2.08	.00	.00	65.	539.	539.	902.	1041.
A/H	687.	.4062	220.5	12.	92.5	95.5	88.3	6238.	0.	2061.	4816.9	1322.8	1322.8	4990.4
	4894.0	.0000	220.5	0.	628.2				6270.3					1536.6
	1344.0	186.63	.0		172.5				6270.3					81.69
		516.2	533.6						7686.2					

TIME	COWS HK1 CCS FC SC PAST CSUPT	CALFW COWMC RC CGSTF CGSLF SSUPT RR HPA3	HPA1 HPA2 HPA3A PAS_AC SUP_AC1 SUP_AC2 STR_AC FOL_AC	F_P ST_P SC_P ADG_1 ADMY1 HRSTAC1	SALES1 SALES2 SALES3 ADG_2 PR HRTPAS HRTSUP	COSTS1 COSTS2 COSTS3 ADG_3 SR	PROFIT1 PROFIT2 PROFIT3 ADG_4 WR	TDNPLB1 TDNPLB2 TDNPLB3 ADG_5 CW_TDN	TDN1 TDN2 TDN3 ADG_6 STRT TDNCK1 TDNCK2 TDNCK3	COSTLB1 COSTLB2 COSTLB3 HWT FDLT	CPPTDN1 CPPTDN2 CPPTDN3 W_W PSTDN	PRPLB1 PRPLB2 PRPLB3 ST_W SPTDN1	TOT_AC1 TOT_AC2 TOTAC3 S_W SPTDN2	PPA1 PPA2 PPA3A CC_W BRT TOT_AC3 PPA3
35. H/A	1000. 215. 192. 643. 637.	858. 121.94 170.95 .0000 .4103	354.4 352.1 377.7 1340.4 221.9	.493 .500 .498 1.88 12.	240.92 241.52 357.99 1.00 93.8	139.94 139.94 236.63 1.50 91.5	100.98 101.58 121.36 2.13 85.8	11.53 11.61 9.85 .00 6259.	6385.2 6385.2 7737.9 .00 0.	.2527 .2544 .3011 65. 2124.	.0219 .0219 .0306 554. 4905.7	.1824 .1847 .1545 554. 1331.3	1562.2 1562.2 2080.2 924. 1331.3	64.64 65.03 73.28 1029. 5007.2
	4923.0 1336.0	.0000 211.73 503.0	221.9 .0 517.9	0.	717.3 194.7				6385.2 6385.2 7737.9					1562.2 77.69
42. A/B	1000. 255. 232. 563. 557.	818. 122.45 171.46 .0000 .4226	363.0 360.9 375.7 1314.8 216.1	.495 .500 .503 1.94 12.	236.03 236.16 334.45 1.00 86.6	140.60 140.60 222.55 1.50 94.5	95.43 95.56 111.91 1.98 81.8	11.31 11.37 9.95 .00 6303.	6285.2 6285.2 7431.0 .00 0.	.2530 .2544 .2981 65. 2056.	.0224 .0224 .0299 568. 4812.3	.1717 .1729 .1499 568. 1296.8	1531.0 1531.0 1987.1 916. 1296.8	62.33 62.42 70.09 1019. 5042.4
	4965.0 1338.0	.0000 251.63 487.6	216.1 .0 456.1	9.	860.7 232.0				6285.2 6285.2 7431.0					1531.0 73.10
49. B/A	10 0. 245. 222. 583. 577.	828. 124.36 173.37 .0000 .4118	352.0 349.9 372.2 1368.7 230.1	.487 .500 .504 1.94 12.	237.63 240.38 353.55 1.00 93.4	145.71 145.71 237.03 1.50 88.7	91.92 94.67 116.53 2.22 82.8	11.65 11.72 10.03 .00 6379.	6558.9 6558.9 7839.0 .00 0.	.2589 .2604 .3034 65. 2217.	.0222 .0222 .0302 568. 5009.5	.1633 .1692 .1492 568. 1380.3	1598.8 1598.8 2098.8 952. 1380.3	57.50 59.21 69.81 1045. 5103.2
	5001.0 1374.0	.0000 241.54 488.6	230.1 .0 500.1	0.	833.8 229.8				6558.9 6558.9 7839.0					1598.8 72.88
56. H/SG	1000. 275. 251. 524. 519.	799. 130.64 179.65 .0000 .4339	370.2 368.2 377.2 1360.2 236.8	.495 .500 .487 2.10 13.	247.47 247.60 334.88 1.00 83.0	148.94 148.94 230.26 1.50 96.3	98.53 98.66 104.62 2.07 79.9	11.15 11.21 9.97 .00 6693.	6588.4 6588.4 7728.0 .00 0.	.2520 .2533 .2970 65. 2195.	.0226 .0226 .0298 607. 4978.2	.1667 .1678 .1349 607. 1420.7	1596.9 1596.9 2055.6 968. 1420.7	61.70 61.78 64.28 1088. 5354.4
	5207.0 1486.0	.0000 270.71 485.5	236.8 .0 458.7	0.	980.3 279.8				6588.4 6588.4 7728.0					1596.9 65.51
63. SG/H	1000. 269. 245. 537. 532.	805. 129.49 178.50 .0000 .4208	355.6 353.7 369.3 1389.4 244.2	.484 .500 .485 1.99 13.	239.75 243.18 334.05 1.00 90.1	151.91 151.91 234.90 1.50 89.4	87.85 91.28 99.15 2.14 80.5	11.59 11.66 10.19 .00 6603.	6735.8 6735.8 7898.9 .00 0.	.2615 .2629 .3031 65. 2188.	.0226 .0226 .0297 581. 5085.3	.1512 .1580 .1279 581. 1465.3	1633.6 1633.6 2098.9 952. 1465.3	53.77 55.87 60.54 1100. 5282.4
	5126.0 1477.0	.0000 264.51 474.4	244.2 .0 465.2	0.	941.0 271.1				6735.8 6735.8 7898.9					1633.6 60.69

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BIOGRAPHICAL SKETCH

Hines Finlayson Boyd was born March 7, 1943, in Valdosta, Georgia. He is the son of Mr. and Mrs. Fred A. Boyd, Sr. He grew up on a farm in rural Jefferson County, Florida and attended the public schools there, graduating from Jefferson County High School at Monticello in June 1961. He then enrolled at Florida State University where he received a Bachelor of Science degree in chemical science and Master of Science degree in higher education.

He continued his graduate studies at the University of Florida in the Department of Microbiology, College of Medicine where he received a Master of Science degree in June 1970. He then enrolled in the Department of Animal Science where he has pursued a doctoral program.

In 1974 Boyd established a private farm management and consulting firm in Tallahassee, Florida. He is married to the former Janegale McDowell. They have one son, Whitson Hines.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Marvin Koger

Marvin Koger, Chairman
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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